BULLETIN

CONTENTS

Max Planck	K. A. G. Mendelssohn	1
The Function of a University Physics Department	H. Lipson	7
Awards to Students		9
Notes and News		10
Reviews of Books		12
Branch and Group Committees		15
Forthcoming Institute Meetings		16
The Register		20
The Institute's Journals		22

THE INSTITUTE OF PHYSICS

Officers and Members of the Board, 1958-59

President :

SIR GEORGE THOMSON, M.A., LL.D., Sc.D., Hon.F.Inst.P., F.R.S.

Immediate Past Presidents :

SIR JOHN COCKCROFT, O.M., K.C.B., C.B.E., M.A., D.Sc., F.Inst.P., F.R.S.
O. W. HUMPHREYS, C.B.E., B.Sc.. M.I.E.E., F.Inst.P.

Vice-Presidents :

B. P. DUDDING, M.B.E., A.R.C.S., Ph.D., F.Inst.P.
PROF. E. A. OWEN, M.A., Sc.D., F.Inst.P.
PROF. E. C. STONER, B.A., Sc.D., F.Inst.P., F.R.S.
R. W. SILLARS, B.A., D.Phil., M.I.E.E., F.Inst.P.

Honorary Treasurer :

J. TAYLOR, M.B.E., D.Sc., F.R.I.C., F.Inst.P.

Honorary Secretary :

PROF. F. A. VICK, O.B.E., Ph.D., A.M.I.E.E., F.Inst.P.

Ordinary Members of the Board :

M. R. HOPKINS, M.Sc., Ph.D., F.Inst.P.
J. M. A. LENIHAN, M.Sc., Ph.D., A.M.I.E.E., F.Inst.P.
A. C. MENZIES, M.A., D.Sc., F.Inst.P., F.R.S.E.
F. OLDHAM, M.A., B.Sc., F.Inst.P.
J. THEWLIS, D.Sc., F.Inst.P.
J. TOPPING, M.Sc., Ph.D., F.Inst.P.
L. R. G. TRELOAR, D.Sc., Ph.D., F.Inst.P.
G. W. WARREN, M.B.E., B.Sc., F.Inst.P.

Chairmen of Branches in Great Britain :

Liverpool and North Wales : F. I. HURLEY, B.A., B.Sc., F.Inst.P.
London and Home Counties : PROF. A. M. TAYLOR, M.A., Ph.D., F.Inst.P.
Manchester and District : PROF. H. LIPSON, M.A., D.Sc., F.Inst.P., F.R.S.
Midland : R. E. BASTICK, B.Sc., Ph.D., A.Inst.P.
North-Eastern : O. P. T. KANTOROWICZ, Ph.D., F.Inst.P.
Scottish : R. M. SILLITTO, B.Sc., F.Inst.P.
South Wales : M. R. HOPKINS, M.Sc., Ph.D., F.Inst.P.
South-Western : PROF. S. H. PIPER, D.S.O., D.Sc., F.Inst.P.
Yorkshire : PROF. W. SUCKSMITH, D.Sc., F.Inst.P., F.R.S.

Nominated by The Physical Society :

H. H. HOPKINS, D.Sc., F.Inst.P.
D. A. WRIGHT, D.Sc., F.Inst.P.

Secretary :

H. R. LANG, B.Sc., Ph.D., A.R.C.S., F.Inst.P.

Deputy Secretary :

N. CLARKE, B.Sc., F.Inst.P.

---

47 BELGRAVE SQUARE, LONDON, S.W.1. TELEPHONE : BELGRAVIA 6111-2-3

THE INSTITUTE OF PHYSICS

Vol. 10 No. 1 **BULLETIN** JANUARY 1959

Published by The Institute of Physics for circulation to its members

Max Planck *

By K. A. G. MENDELSSOHN, M.A., D.Phil., F.Inst.P., F.R.S.

(*University of Oxford*)

THE year 1958 marks the centenary of the birth of Max Planck. The second half of this century has seen one of the greatest revolutions through which science and philosophy have ever passed and which was initiated by his work. For the young physics student of to-day, Planck's name ranks with those of Galileo and Newton. For them it has become the name of a basic principle of physics rather than that of a person. Most of us who knew him, remember Planck only as a man in advancing years with a kindly manner and a correct, if somewhat old fashioned, way of dressing. The dark suit with the starched shirt and the black bow tie fitted well with his quiet speech, and the careful choice of words would have marked him out as a typical member of the Prussian higher Civil Service, had it not been for the penetrating eyes under the huge dome of his forehead. When I entered Berlin University in 1925, I belonged to the last class of students to whom Planck gave his famous course of lectures on theoretical physics. Three years later, at the age of seventy, he retired from his professorship which he had held for almost forty years.

However, Planck's retirement from teaching did not mark the end of his interest in physics and he remained a regular participant in the Berlin physics colloquium which was then the main forum for the discussion of current results and ideas. In this gathering his personality impressed itself less forcefully on to the memory of the young generation than that of some of the other members. There was Nernst, temperamental, uncompromising and full of intuition ; Einstein, beautifully clear, with a gentle humour and hardly a doubt ; von Laue, searching and forceful, if inarticulate; and Schrödinger, critical but enthusiastic. It seemed strange to us that it should have been Planck, with his meticulous and slightly pedantic manner of lecturing, who had provided the basic idea on which most of these discussions centred. It was even said, half jokingly, that Planck did not like the quantum theory and there is a grain of truth in this statement which perhaps holds the key to the understanding of his real greatness. Owing to his background and training, Planck had strong convictions about the nature of the laws of physics and it required an almost superhuman strength of logic and intellectual honesty to discover and uphold a concept which conflicted with the basis of his belief. He was an ultra-conservative whom the love for truth had turned into an unwilling revolutionary.

Max Karl Ernst Ludwig Planck was born on April 23, 1858, at Kiel in the Duchy of Holstein where his father was Professor of Law. The Planck family has given Germany a number of distinguished scholars and civil servants. The father's cousin was also a Professor of Law, at Göttingen, and later became famous as the founder of the German Civil Code. There can be little doubt that the necessity of rule by laws was deeply ingrained in Max Planck's mind but he was drawn not so much to the codification of human activities as to the more fundamental laws of nature. In his scientific autobiography he explains his choice of study because he was impressed by the similarity between the laws governing thought and those " in the sequence of impressions which we receive from the outer world." The cautious and careful wording of this sentence is as characteristic of Planck as its meaning.

The conviction that the laws of physics must be " absolute," not admitting of any exception, returns again and again in Planck's papers and lectures throughout his long life. Family tradition and the stability of the world in which he spent the formative years made him feel that his conviction must be correct. Planck was a schoolboy of thirteen when Bismarck founded the German Reich and he lived through the holocaust of its final destruction in 1945, but he was already sixty when this stability was shaken for the first time. It was this search for the absolute law which determined not only Planck's particular field of research but also the way in which he approached it.

At school in Munich, where the family had moved in 1867, Planck received the law of conservation of energy " like a message of salvation " and he recalls the impression which the example made on him by which this law was illustrated. A brick which had received energy by being lifted up to a high building would retain this energy for many years after which it could be released when the building crumbled and the brick fell on somebody's head. When leaving school, Planck decided in

* A lecture given to the Education Group of the Institute at the Institute's House on November 19, 1958

favour of physics, his other interests being classics and music. He first studied in Munich and then went to Berlin where the writings rather than the lectures of Helmholtz and Kirchhoff furthered his interest in the law of energy conservation. Reading Clausius' papers, he learned for the first time of the qualifications which are imposed on energy changes by the second law. Far from regarding the latter as a complication, Planck was fascinated by the entropy concept because it indicated the direction of a process and thus gives more information than is contained in the first law. It is typical for Planck that his first original contribution to physics dealt with a more concise formulation of the concept of irreversibility which, he felt, had been too loosely defined by Clausius On the basis of his considerations he deduced that, whereas for a reversible process there is no distinction between the original and the final state of the system, the final state of an irreversible process is distinguished by a " preference " which nature expresses for it. Planck then showed that the Clausius entropy was the measure for this preference in a " natural " process. He made this work the subject of his doctoral thesis and later pointed out that its effect on the physicists of the day was strictly zero. Conversation with his Munich professors convinced him that they had no interest in it and he suspected that he received the degree only because they knew his class work. Helmholtz did not read the thesis and Kirchhoff disapproved of it because he did not like the application of entropy to irreversible processes. Clausius was the last hope but he did not reply to letters and when Planck went to Bonn in the hope of meeting him personally, he did not find Clausius at home.

This was in 1879. Planck's method of attacking the energy problem was that of pure thermodynamics and he did not deviate from it for another twenty years. It was a corollary of his basic belief in the identity of the laws of physics and of thought, that the former can be discovered by thought processes. In this search for the absolute law, the strict but generalized formalism of thermodynamics appealed to him particularly. He was impressed by the fact that in pure thermodynamics the path of a process could be ignored, only the initial and final states being of relevance. He felt sure that the energy laws must have the same absolute validity as those of Newtonian mechanics.

At first the lack of interest shown by his colleagues did not deter Planck from following up his work on the second law with a number of papers in which he deduced from it the equilibrium conditions of physical and chemical systems, dealing first with phase changes and then with gas mixtures. He was, however, depressed when he learned later that he had merely repeated the earlier work of Willard Gibbs and that the results of his work were no fresh contribution to knowledge.

In 1885 Planck was offered an assistant professorship in Kiel and he records that his delight was not even tempered by the suspicion that he owed the position less to his scientific reputation than to the fact that the head of the department was an old friend of his father's. He felt that the professorship gave him the opportunity for wider scientific activity and he wished to make the most of it. The work on the second law was further extended and his well-known papers on the dissociation of gases and on the properties of dilute solutions fall in this period. This work led to a controversy between Svante Arrhenius and Planck in which the former pointed out that in electrolytic dissociation the particles are charged to which Planck replied that the laws of thermodynamics have general validity, whether the particles are charged or not. A little earlier Planck had sided with Helmholtz in his dispute with Weber. This work had lost him the sympathy of the faculty in Göttingen and with it the first prize which Planck had hoped to win with a treatise on the nature of energy. On the other hand, the paper created interest in Berlin and in 1889 he was asked to come to Berlin as successor to Kirchhoff. There he remained not only to his retirement but almost to the end of his long life. The move to Berlin meant for Planck the beginning of the most fruitful phase of his life. He delighted in the company of men who, in his own words, " were then the world's scientific leaders." His friendship with Helmholtz changed from admiration to true devotion and Planck records that he rated Helmholtz's praise higher than any public success. Among the other physicists the successive directors of the Physical Institute, Kundt and Rubens, seem to have been his closest friends.

The appointment to the Berlin professorship also had its effect on Planck's colleagues at the other universities who began to correspond with him and the time when his own letters had remained unanswered was now definitely over. He became interested in the theory of electrolytes developed by Nernst in Göttingen and the ensuing correspondence led to a co-operation in ideas which was to become extremely fruitful in the next three decades. Another correspondence on the same subject, however, led to wide disagreement and eventually to very outspoken argument. This was the exchange of views between Planck and Wilhelm Ostwald.

After the formulation of the law of conservation of energy in the middle of the nineteenth century, Rankine had proposed a theoretical system which he called "energetics" and in which it was hoped to explain all the physical phenomena in terms of energy. Not much headway was made at the time but more than thirty years later the great chemist Ostwald revived these ideas not only as a basis for theoretical physics but as a philosophical concept. He felt certain that the energy concept held the key to a unified description of all the known laws of nature and that the system of energetics would rapidly remove all existing discrepancies and uncertainties in physics. Unfortunately, his own and the enthusiasm of his followers led to hasty and somewhat vague formulation of the basic principles of energetics.

Half a century later Planck refers to his correspondence with Ostwald as critical but always friendly. Finally, the matter came to a head when in 1896 Boltzmann subjected in the *Annalen der Physik* Ostwald's book and one of his lectures to detailed and devastating criticism. In a paper, immediately following that of Boltzmann, Planck associated himself with the attack on Ostwald without, however, mentioning the latter's name. Neither did he make reference to Boltzmann's paper but it is noteworthy that the *Annalen* were edited " in collaboration with Physical Society of Berlin and especially with M. Planck." Boltzmann's paper is dated : " Vienna, November 2, 1895 " and Planck's : " Berlin,

December, 1895." Both Boltzmann and Planck were extremely outspoken and the title of Planck's paper *Gegen die neuere Energetik* (Against the newer energetics) has the ring of a Lutheran thesis. He simply showed, on the example of an ideal gas, that one of Ostwald's definitions, the volume energy, has no physical significance.

Planck's curious attitude in associating himself with the attack on Ostwald but not associating himself with Boltzmann receives its explanation in the same volume of the *Annalen*. Also in December, 1895, Zermelo, a young pupil of Planck's, had submitted a paper in which he tried to show that Boltzmann's statistical interpretation of thermodynamics was not applicable. Zermelo based his attack on a theorem by Henri Poincaré according to which any dynamic condition of a set of point masses is bound to recur after some time and this would be at variance with an irreversible process. Boltzmann, within three months and still in the same volume of the *Annalen*, had no difficulty in demonstrating that, while Poincaré's theorem was correct, it could not be applied to thermal processes. He was slightly irritated and suggested that Zermelo would probably suspect the dice to be loaded since he had been unable to throw a one, a thousand times running, because the probability for such an event was not zero.

It is quite clear that Boltzmann was right and that Zermelo, and with him Planck, had failed to appreciate the significance of the statistical approach. Planck's failure must appear very human because he freely admitted later on that he did not wish to see the significance of statistical methods. His whole outlook in physics was determined by the search for absolute laws of nature and he felt that the laws of probability could not have a place in such a basic theorem as the second law of thermodynamics because he wanted this law to express a certainty. When in the following year his famous text book *Thermodynamik* appeared, he reiterated his conviction in the preface. There are, he said, three different theoretical methods in thermodynamics. The first, that of Maxwell and Boltzmann, is based on the concept of kinetic molecular motion which, besides requiring detailed assumptions concerning the structure of matter, involves difficulties of principle. The second method, of Helmholtz, does not demand such a detailed picture and only in general terms assumes heat to be based on motion. However, this limitation of assumptions also entails a severe limitation of applicability. The third method, the one favoured by Planck and on which he bases his book, makes no assumptions at all either about the nature of matter or that of heat. Instead the whole treatment is developed logically from very general, empirically determined, laws of nature. The inference is, of course, that these are absolute laws, and, since the logical conclusions in the human mind represent a true replica of physical causality, they must lead to true results.

I have mentioned these events in some detail because it is important to be clear about Planck's ideas on the nature of physical laws three years before he formulated the quantum concept. Only in this way can we appreciate the magnitude of his achievement.

Planck's predecessor, Kirchhoff, had considered the establishment of thermal equilibrium in a radiation enclosure and had come to the conclusion that the intensity and spectral distribution depends solely on temperature. The surprising result that the radiation was independent of the nature of the radiating matter immediately attracted Planck's interest because he realized that the relation between black body radiation (*Hohlraumstrahlung*) and temperature must represent another of the absolute laws of physics. Moreover, two independent experimental investigations into the energy distribution of radiation were being pursued at that time in Berlin, and Planck was in close contact with the progress of the research.

The first attempt to find a radiation formula failed. Planck had based it on Maxwell's electrodynamic theory and hoped to show that a system of linear oscillators with different frequencies would lead to energy exchange between the frequencies and to the establishment of the observed radiation distribution. This did not turn out to be so and the treatment in addition, provoked Boltzmann's criticism. In his disappointment Planck turned to the other absolute law which had held his attention so long and began to investigate the relation of energy with entropy rather than with temperature. It was this approach which eventually yielded the significant result and, surveying the trend in physics publications at the time, it is clear that it was Planck alone who by the choice of his previous work and his scientific inclination was predestined to use this particular theoretical method. He himself said that the lack of interest in the entropy concept on the part of his colleagues provided him with the peace of mind necessary to complete his calculations without fear of being disturbed or of being anticipated.

Applying the energy-entropy relation to Wien's radiation law, Planck was delighted to discover an extremely simple relation which he thought at first to be of general validity. However, just then the radiation measurements of Kurlbaum and Rubens in Berlin were being extended to longer wavelengths and the results began to show an unmistakable deviation from Wien's formula towards the law postulated at about the same time by Lord Rayleigh on the basis of statistical considerations. On October 19, 1900, Kurlbaum communicated this work to the Berlin Physical Society, but the authors had informed Planck beforehand of the trend of their measurements. By an ingenious combination of the two laws Planck arrived at his famous radiation formula in which by the use of two constants the relations of Wien and Rayleigh-Jeans appeared as the limiting cases. In a contribution to the discussion after Kurlbaum's lecture, Planck submitted his own equation. Rubens called on him the next morning to say that in the night he had compared their experimental values with the new formula and had found complete agreement.

In this discussion remark, Planck first explained his approach along the entropy consideration and then stated that he had formed a number of arbitrary expressions for the entropy. From these he had selected that which was by far the simplest logarithmic relation between entropy and energy. He thus claimed no more than an empirical relation, based on the choice of simplicity for a fundamental law. This fateful choice was thus based on Planck's firm belief in the analogy of human thought processes to the laws of nature.

The title chosen by Planck for this short paper is significant. It reads : *Uber eine Verbesserung der Wien'shen Spektralgleichung* (Concerning an improvement of Wien's spectrum formula). In his modesty he felt that he had not yet made a fundamental contribution because, although finding the correct equation, he had failed to invest it with physical meaning. In the following two months Planck discovered that meaning in a unique achievement of rigorous logic and devastating self-criticism.

In its integrated form Planck's radiation formula gives for the entropy S of an oscillator of frequency ν,

$$S=\frac{a'}{a}\left\{\left(\frac{U}{a'\nu}+1\right)\log\left(\frac{U}{a'\nu}+1\right)-\frac{U}{a'\nu}\log\frac{U}{a'\nu}\right\}$$

where U is the energy and a' and a constants. In order to gain insight into the physical significance of this expression, Planck was forced to have recourse to Boltzmann's statistical interpretation of the second law. How very hard this change of attitude must have been for Planck is clear from his own words, written forty-two years later : " Until then I had not been interested in the relation between entropy and probability. It did not appear attractive to me because any law of probability admits to exceptions and because, at that time, I ascribed to the second law validity without exception." He makes no bones about the fact that he was driven to " Boltzmann's method " because he could not see any other way. He then goes on to point out that the determination of a probability requires counting and " therefore it was above all necessary to regard the energy as the sum of discrete equal elements." He presented the argument in exactly the same form in his first publication of the quantum principle when on December 14, 1900, he addressed again the Berlin Physical Society, introducing in the same sentence " the natural constant $h=6{\cdot}55\times10^{-27}$ erg sec."

He had arrived at it by considering a number N of equal oscillators with average energy U and by assuming the total energy to be made up of a number P of equal energy elements ε, so that $NU=P\varepsilon$. Forming the complexion which gives the number of ways in which the P energy elements can be distributed over N, and which is the required probability, he calculated the entropy of the oscillator system as :

$$N\,S=k\log\frac{(P+N)\,!}{P!\;\;N!}$$

which can be written in the form :

$$S=k\left\{\left(\frac{P}{N}+1\right)\log\left(\frac{P}{N}+1\right)-\frac{P}{N}\log\frac{P}{N}\right\}$$

This theoretical expression is identical with the semi-empirical interpolation formula if a'/a is set equal to k and a' becomes the new universal constant h.

There is a curious contrast in this first paper between the manner in which the energy quanta are introduced—almost as a mathematical oddity—and a sentence in the introduction in which he clearly said that he believes his work to be of far reaching importance " for other fields of physics and also of chemistry." There can thus be no doubt that even at this early stage Planck had realized the significance of his theory but it is equally clear that he had no intention of emphasizing, or even acknowledging, its revolutionary character. Instead, his efforts were now directed towards finding a place for his quantum of action in the framework of classical physics. He freely admitted more than forty years later that he had not suspected the break away from classical theory to be " so radical." Logic, to which Planck gave even greater weight than to his concept of absolute laws, had forced him to acknowledge the correctness of the hateful statistical approach. It was now forcing him to doubt the whole system of classical physics in which he had been trained. He thoroughly mistrusted, not the validity, but the physical significance of the concept which he had created in spite of himself. Planck, whose ancestors made it their business to uphold the law, was in no hurry to overthrow classical physics, a task which in the end he left to Einstein, and very little was heard about the quantum theory for another five years.

In the famous volume of the *Annalen* in 1905, which also contains his work on relativity and on Brownian motion, Einstein published a paper on " the production and transformation of light " in which he replaces the classical aspect of light as a continuum by corpuscular radiation of energy quanta. He uses this to explain the experimental data on the photo-electric effect and on the ionization potentials. Two years later there followed his quantum theory of the specific heat of solids which, in the range of temperatures then accessible, yielded a brilliant interpretation of Weber's experimental results on diamond.

Einstein was then still at Berne which precluded any close collaboration between him and Planck at that time. Moreover, the way in which Einstein's first paper is presented shows that he regarded his own idea of the quantized nature of all energy exchanges as new and as a generalization of Planck's introduction of h in the radiation formula. Indeed, apart from the surprising sentence—already quoted—in the introduction to Planck's fundamental paper, Planck avoided for a long time generalization of his theory and in particular he evidently did not like to acknowledge the physical existence of energy quanta. It has to be remembered that his work of 1900 had involved two distinct steps and that he disliked both. The first had been the victory—in his own considerations—of Boltzmann's statistical interpretation. How profoundly this had affected him is shown in the preface to the second edition of his *Thermodynamik* in 1905. In his severe self-criticism and honesty he refers here to the opinions expressed in the first edition and revises them completely, crediting Boltzmann with the revelation of the physical meaning of the second law. In support he quotes the work on black body radiation by Wien, Rubens and Kurlbaum, and by others. However, the second step, the quantum theory—now in its fifth year—is not mentioned.

This preface is dated January, 1905, two months before Einstein's first paper was written. In the spring of 1906 Planck published his *Wärmestrahlung* based on his lectures in the winter 1905-06. The preface mentions his radiation theory but the reader is told in the following sentence that it is by no means complete. Einstein's work is quoted neither here nor in the preface to the second edition in 1912. Finally, in 1921, Planck

makes full acknowledgment of Einstein's contributions but even then he cannot quite overcome his cautious attitude with regard to the light quanta. He points out that in the ideas about the propagation of light two different concepts, that of a " smooth " and that of a " spotted " wave front, remain irreconcilable.

In between the two Einstein papers another important development had taken place : Nernst's enunciation of the third law of thermodynamics. This was much closer to Planck's way of thinking than Einstein's photon gas and in the 1912 preface of *Wärmestrahlung* he makes enthusiastic reference to it. His own formulation of Nernst's theorem, zero entropy at absolute zero, he regards as " the true basis of the quantum hypothesis " but, typically, qualifies the statement by saying " so far." With Nernst's appointment to a professorship in Berlin in 1905 Planck's collaboration with him became even closer and while Nernst, the experimentalist and theoretical chemist, lacked Einstein's insight into the meaning of the quantum theory, he made up for it by an unequalled degree of common sense. The quantization of the specific heat of the ideal gas is an example of this. As early as 1914 Nernst postulated the existence of " gas degeneracy " simply because he felt—and rightly so—that his theorem was a universal law and as such was unlikely to be limited in its validity to condensed phases. Considerations of this kind led Planck over the zero point energy of $\frac{1}{2}h\nu$ per oscillator to a fuller understanding of the meaning of the third law.

While Planck does not appear to have been too happy with Einstein's interpretation of the quantum theory, he was greatly impressed with his theory of relativity. Planck was not worried by the relativity principle. He pointed out that, since the relative presupposes the existence of something absolute, relativity underlines his own search for absolute laws. He was delighted with the invariance of the light velocity, postulated by Einstein as the cornerstone of his theory because this invariance led to a more absolute description of the space-time relation than is provided by classical theory. Much later Planck likened the invariance of the light velocity in relativity to his own quantum of action as the basic principles of the two great physical theories of our time. From 1906 onwards Planck published a number of papers on relativity and among them a long one in 1908 in which he relates relativistic mechanics and thermodynamics through Einstein's law of the equivalence of mass and energy. This paper also contains a remarkable instance of what might almost be called scientific clairvoyance. He comments on the immense energy which is locked up in the rest mass of matter and then goes on to say that, while only ten years earlier the idea of obtaining this energy must have appeared remote, the discovery of radioactivity had brought it into the range of the possible. He must have felt like a prophet of doom when, almost forty years later and two years before his death, he learned about the destruction of Hiroshima and Nagasaki.

However cautious Planck had been concerning the physical significance of his quantum of action, from the year 1913 onwards it became the guiding principle of modern physics. In that year Bohr's first paper on the quantized atom model was published and in spite of the war progress in the application of the quantum principle became rapid. Planck himself took his full share of the work, but even so, from then the initiative in quantum physics passed into the hands of a new generation. Planck retained his interest in various fields of physics to a remarkable age. His last strictly scientific paper, in which he tried to bridge the gulf between wave and particle mechanics was published when he was eighty-two, again in the *Annalen*.

However, from 1930 until his death Planck showed an ever widening interest in the philosophical implications of scientific research. The search for absolute laws and his belief in the parallelism between the laws of nature and human thought were the mainspring of his scientific work. He was deeply religious and scorned the narrow outlook of positivism which he had already attacked sharply in his controversy with Mach twenty years earlier. Philosophical articles and some reminiscences form most of his last publications. However, Planck's very last paper, written in the year of his death, strikes a sombre note. It is nothing more than a short paragraph in the *Physikalische Blätter* with the title " My visit to Adolf Hitler." In it he describes his useless attempt to retain in Germany outstanding Jewish scientists, such as Haber. In his capacity as Secretary of the Prussian Academy of Sciences, Planck had to call on Hitler in the spring of 1933 and had hoped to use this opportunity of influencing official Nazi policy. Hitler's wild and senseless tirade which he received in reply convinced Planck that nothing could be done.

When, in 1947, Planck wrote the account of this interview, Hitler had inflicted on him, the last, but perhaps the most painful, of his many personal losses. Planck's first wife died in 1909. There were four children of this marriage ; two boys, Karl and Erwin, and twin girls, Emma and Grethe. Karl was killed near Verdun in 1916. Emma died at the birth of her first child and when her sister Grethe married the widower, she, too died in childbirth. Erwin who had entered the diplomatic service was accused of having taken part in the plot to assassinate Hitler, and was cruelly put to death by the Nazis shortly before the end of the war. The two grandchildren which the death of his twin daughters had left with Planck were largely educated in his house, together with his own young son Hermann, born of Planck's second marriage. It is clear from chance remarks that Planck was acutely aware of the responsibility which he, a man now over sixty, felt for the upbringing of this rather young family.

The evenness of temper which expressed itself before the students in the somewhat dry manner in which his lectures were delivered has been remarked upon by his closer associates. To fill in a few details regarding Planck's personality, I must draw on their accounts, published or given to me verbally. They all were impressed by Planck's simple friendliness and by the hospitality offered at his house in the Wangenheimstrasse in the Grunewald suburb of Berlin. He appeared to them approachable but never inviting or showing any familiarity. The cautious reserve, so well expressed in his published papers, extended to the discussions with his co-workers, and Lise Meitner records that whenever she asked his opinion on a problem, Planck would say, " I will give you my answer to-morrow."

His faith in God, which was so closely linked with his idea of the laws of nature, seems to have helped him to bear with great fortitude his personal losses. He did not become embittered and remained all his life an essentially happy man. The concept of the well ordered universe in which Planck lived had a strong influence on his own mode of life, which also was extremely well ordered. There would be a sizeable walk every day as well as half an hour of piano playing. His work was done standing at a high, old world writing table. In the vacation he always took long holidays which were mainly spent in the Alps. He was an enthusiastic mountaineer and Born mentions that he visited Planck once in Trafoi when the latter, although well over sixty, had just returned from climbing a 12,000 foot peak.

Planck detested all ostentation and subjected to his old age his hardened and healthy frame to daily journeys in the " hard " class of the Berlin suburban trains. This was the only place outside the lecture room or scientific meetings where I ever saw Planck, except for one, unexpected, occasion when I saw him at a late night Berlin West-end cabaret. He must have been just seventy and he had taken his wife and a friend. They came in late and Planck laughed good humouredly when the comedian on the stage commented on the advanced age and the very bald head of the newcomer. The forbidding and reserved figure who had remained distant to the young student for three years, had suddenly become warm and human.

His last visit to this country took place at the occasion of the Royal Society's Newton celebrations in 1946. Planck was made one of its Foreign Members in 1926, seven years after he had been awarded the Nobel Prize. Planck travelled extensively, if for no other reason to accept honorary degrees from universities and membership of national academies all over the world. Although Planck's great discovery was made when he was already forty-two, and although he himself did nothing to advance it for years after, he lived to see the enormous change which it produced in physics, chemistry and biology. Since 1930 he was the President of the national German research foundation, the Kaiser Wilhelm Gesellschaft which is now the Max Planck Gesellschaft. He had become the outstanding figure in German physics long before his death and when in the early twenties the theory of relativity and Einstein personally were wildly attacked, it was Planck's undisputed authority which put an end to these anti-Semitic machinations.

It is hardly possible to think of two men of science who were more different in temperament, views, upbringing and background than Planck and Einstein. This opposition of personalities, coupled with common interest in physics and common love for music brought about a curious but close personal friendship. I have mentioned earlier that Planck's cautious reserve towards Einstein's radical championship of the quantum theory did not signify any disapproval of Einstein as a theoretical physicist. On the contrary, Planck at first showed outwardly a much greater regard for Einstein's relativity theory than for his own quantum of action. Together with Nernst and Haber, Planck used his influence with the Prussian Academy of Sciences to bring Einstein to Berlin. The Academy, in 1913, created a special chair for Einstein to allow him to follow his research in closest contact with the most outstanding exponents of German physics. Einstein, with his violin and Planck at the piano often spent long hours together, playing chamber music. Planck had retained and developed his early interest in music and he was a very good pianist who liked to play and improvise on themes of classical music or on folk songs.

Contrary to Sommerfeld who created a world famous school of theoretical physics in Munich, Planck had only a small number of pupils whose research work he directed. His lectures did not fire the undergraduates with enthusiasm and the young graduates were possibly frightened by the high standards and by Planck's reserve and cautious approach. Among the few who worked closely with him are foremost, von Laue and Lise Meitner. Zermelo has already been mentioned. There were also Reiche, and Abraham who wrote the well-known textbook on electromagnetism. Another very promising pupil, von Mosengeil, died quite young.

It is difficult for the outsider to visualize the dilemma and anguish which the rise of Nazism must have caused in Planck's mind. Through the tradition of his family and by the experience of his own long life, love of Germany was deeply engrained in his personality. Moreover, service of his country and regard for the authority of its rulers were matters which could not be questioned by a man of Planck's background. It is significant that he did not seek an audience with Hitler to protest against the treatment of his Jewish colleagues, but that he took the opportunity of a routine call which he had to make to the new Head of State to intercede on behalf of Haber because of the latter's service to Germany in the first world war. The failure of his mission in 1933 seems to have prevented any further attempts on his part to express difference of opinion with the State Authorities. He remained in his position at the Academy and as President of the Kaiser Wilhelm Gesellschaft for the Advancement of Science. However, while no statement of opposition from Planck is recorded, it is significant that in his (posthumously published) diary, Goebbels mentions Planck's name, saying that he was " reserved, to put it mildly " in his attitude towards the Nazis.

Perhaps Planck hoped that law and order would eventually re-establish themselves in Germany but it is also possible that, with his clarity of vision, he may have long foreseen the final catastrophe. When it came, it not only took his son, but drove him from his home. His house near Berlin was destroyed and his beloved library was burned. Well over eighty now, he was given shelter on the estate of a friend near Magdeburg. The region became the last battlefield of the retreating German army. Eventually, the Americans despatched a military vehicle to take him to Göttingen where he settled for the remaining two years and a half of his life. However, in spite of his great age and disregarding the difficulties of travel and accommodation, Planck felt it was his duty to give lectures in many parts of Germany. He had witnessed the collapse and annihilation of his world but physics and the quantum theory lived on. Planck rendered service to them to his last day.

Vol. 10, January, 1959

The Function of a University Physics Department*

By Professor H. LIPSON, M.A., D.Sc., F.Inst.P., F.R.S.

(*Manchester College of Science and Technology*)

THE ORIGIN OF THE PROBLEM

IT IS a custom of this Branch that, to compensate for the arduous nature of the Chairman's duties, he is allowed one occasion at which he can air his views. I have given a few lectures to various bodies, but always on topics selected for me ; on this occasion, for the Chairman's address, I have chosen to speak on a topic that no one—at least in his right senses—would have thought that I had any particular qualification to speak about.

After all, I am relatively new to the job of educating physicists. Although my department has been for many years concerned with providing physics for engineers and others, only seven years ago was it entrusted with the task of educating physicists. In those seven years I have had to think deeply about a number of problems that I had not encountered before, either as a research physicist at Manchester, the National Physical Laboratory and Cambridge, or as head of a service department here in Manchester. It is the process of trying to solve these problems that I am going to talk about this evening.

I must necessarily confine myself to physics. Nevertheless, I believe that some of what I propose to say applies to other subjects as well—even to Arts subjects. For the universities have specifically the task of *educating* students, and the subjects chosen should be regarded as vehicles for this task ; it should be possible to educate a student as completely using physics as using history. But that is not the aspect that I wish to speak about now.

All this may sound a bit pompous, and I like to think—how correctly I do not know—that I am not really pompous. I can well imagine my audience asking "Who does he think he is, that he should talk about educating students ? What qualifications has he that the next man hasn't ?" And I can only reply by reiterating these questions. To be a university teacher is to be presumptuous. You wouldn't be in the profession unless you thought you had something to offer. Some committee at one time agreed with you ; and then it was too late to repent. Then you had to think about education and hope that your thinking would bear some fruit !

I propose therefore to take this presumption for granted, and hope that you will bear with me if I seem too dogmatic. To make my points clearly I may somewhat overstate them ; there will be a discussion period in which this fault can be corrected.

Now, what qualifications have I to talk of the functions of a university department ? They are threefold. First, I have had to devise a course from scratch. (I should like to pay tribute here to the valuable help I have received from my staff ; but I think that they will agree that the general outlines were put forward by me, and that on me rested the onus for justifying any decisions and any actions we took). I had no traditions and no system to work on and consequently had to decide for myself what we were trying to do. Secondly, the department has not had a large number of applicants. Thus I have had to justify—to myself, to potential students and others—the existence of a new department in a city which already houses one of the most important physics departments in the world. Thirdly—perhaps most important—my family is now of university age, and I have had to think about problems from the students' point of view as well.

With this rather long preamble, I shall now get down to my self-appointed task.

THE IDEA OF A UNIVERSITY

First, what is a university ? Let us idealize the answer—the physicist's usual first step in trying to solve a problem. A university should be a community of scholars ; the senior people should be concerned with teaching their subject and extending its bounds ; the junior people should be sitting at the feet of their seniors, absorbing their teaching both directly and by example from the way they conduct their affairs. This is the ideal. To my knowledge, it has never existed in practice, except possibly in certain isolated subjects for relatively short periods of time.

What do we substitute for this ideal ? We have, first of all, a system of lectures, in which the lecturer is separated from his students by the barrier of the lecture bench (easily overcome) and of available time (not so easily overcome). In his lectures the lecturer is provided with an opportunity of passing some of his knowledge on to his students, together with, if he wishes, some of his personality. I believe that the latter is as important as the former, but I am well aware that many people would disagree with me. In fact, I have heard it stated that the aim of a lecturer should be complete objectivity ; he should state his facts and let the student base his judgment on them. If this is indeed so, then I think that lecturers could be dispensed with ; the student could get all he wanted from books.

The physics lecturer, in particular, is provided with a further opportunity of making contact with his students ; he can perform experiments to demonstrate phenomena that he is dealing with theoretically. Unfortunately, lecture demonstrations are becoming rare because they take up valuable time and assistants who can carry them out successfully are not easily found. I think that this tendency should be resisted. There is no substitute for the student's seeing a phenomenon enacted before his eyes ; my most successful demonstration to my intermediate class is simply the movement of a current in a magnetic field, and I am sure that it has brought home the reality of the effect much more than any formula could do.

* The Chairman's Address to the Manchester and District Branch given in Manchester on September 22, 1958.

Then there is the laboratory. All physicists have to do practical work—experimental physicists for obvious reasons and theoretical physicists because they must learn how to appreciate the experimental facts upon which they are, later on, to base their theories. The laboratory provides a much better opportunity than the lecture room for personal contact, but here the barriers are the practical notebook and the research-student demonstrator. I believe that undergraduates are often too much concerned with producing a passable notebook than with discussing their problems and airing their views with the staff ; and the extensive use of research students as demonstrators does not help. Research students are too close to their own undergraduate days to see the basic problems clearly ; they are usually too keen, for example, to see that the limits of error have been worked out properly than to see whether an experiment has been carried out with a proper physicist's approach. And they would be horrified at the idea of discussing the hydrogen bomb or the value of sending rockets to the moon with the students during practical periods.* (Or am I wrong ?) Yet I am sure that, at some stage, undergraduates should be discussing affairs of this sort with older and more experienced people.

The increase in size of departments has accentuated these problems. Before the war, a final honours school of double figures was unusual ; now it is common, and indeed some departments are approaching three figures. I believe that there is more than a quantitative difference here : a class of a dozen people can know one another and can be personally known to their professor and other members of staff ; a class of forty cannot. Here I must admit to being a defeatist. I do not see any solution to the difficulty. We cannot multiply the number of university departments by three to reduce classes to reasonable size. But I do think that we must recognize the problem and at least try to mitigate it. Subdivision into smaller groups is a help, so long as a senior person is in contact with each group. He should encourage discussion as far as possible and should try to foster such discussion in the practical laboratory as well.

THE INFLUENCE OF RESEARCH

The use of research-student demonstrators can also be rather debilitating for the undergraduates, but this activity has come to stay ; we must recognize it and again try to mitigate it. Demonstrators must appreciate that it is not their main business to see that each experiment is perfectly performed before the student is allowed to leave it ; he must see rather that each student performs a reasonable variety of experiments giving him a reasonable introduction to physical procedures. Also, as I have said, I think that there is a tendency to excessive pre-occupation with the theory of errors : the completely satisfactory estimation of errors can take a long time ; need the student learn it from *every* experiment he does ?

One may also ask why research students are used so much now ; the ratio of lecturers to undergraduates has not changed so greatly. I think that the answer lies in the greatly increased pre-occupation with research, so that the staff desire more time for research and there are more research students to help with teaching. There is no doubt whatever that universities gain prestige from research, not from teaching, but I nevertheless feel that this problem is one that also has to be squarely faced.

How has the emphasis on research in universities arisen ? As I shall show in the next section, I believe that research is a necessary concomitant of university teaching. But I think that the emphasis on research is, in a way, accidental. It has turned out that the climate of a university department is that in which research flourishes best, in spite of the obvious expectation that the best research should surely be that which is carried out in a place devoted to it, without teaching distractions. If the tendency to emphasize research in place of teaching continues, so I believe will the quality of students tend to decrease ; so will the desire to do research, and the temptation to do research solely for the sake of the kudos it brings will increase. We must guard against these results, I think by re-emphasizing the importance of teaching and making sure that the students know that they are considered as important constituents in the department and not just necessary encumbrances in the way of research.

THE EFFECT OF RESEARCH ON TEACHING

We must, however, be careful—extremely careful—to strike a proper balance. Without active and noteworthy research a department will founder. No lecturer can be really efficient unless he is taking part in research in some aspect of his subject. He should then be able to communicate to his class something of the climate of the subject—how discoveries are likely to arise, why such-and-such a phenomenon was overlooked, how so-and-so's methods differed from his contemporaries'. Textbooks make physics look so systematic, and some students believe that by the cultivation of system they will become good physicists. Far be it from me to dissuade anyone from becoming systematic ! But a research worker knows that discoveries can arise in the oddest moments, that he can dither on the verge of a discovery for a long time while his rival reaches it first, that much depends upon flair as distinct from method. All these factors must be brought home to the student at the same time as the subject is retailed to him. Of course, for the great majority of students the effort may be wasted ; but for the few on whom it is not wasted—who achieve a desire to further the subject—the effort is well worth while.

THE EFFECT OF TEACHING ON RESEARCH

Nor will the lecturer lose by this work. The constant effort to keep up with the subject, to correct errors and misconceptions (for who is free from these ?), to see the place of his subject in relation to physics as a whole, will undoubtedly react on his research. I speak here with feeling, for I know quite clearly how little I knew about my subject until I started to teach it. For about ten years I was using X-ray diffraction methods purely by rule of thumb. I like to think that I was reasonably efficient, and produced some useful results ; but nevertheless it was not until I was asked to give a course of lectures in Cambridge that I realized my deficiencies. In the attempt to put my house in order I began to

* Mr. Lee, the Chairman of the meeting, asked me to leave the sentence in this form !

appreciate the physics behind the subject and I feel now that I can see the relation between X-ray diffraction and physical optics more clearly than had ever been pointed out to me. I believe that this appreciation has improved both my use of X-rays and my teaching of physical optics, and I should not like to revert to the days when I did not know that X-ray diffraction was related to the physics I had learned.

THE STUDENTS' CONTRIBUTION

In this talk I have deliberately emphasized the universities' responsibilities, because I think that, recognizing them, we can shoulder them more successfully. But the student must also recognize *his* responsibilities. He is coming in larger numbers, including, without doubt, a larger proportion of mediocrities. To get the best out of the university such students must make their own efforts, and I am afraid that many of them, having been forcibly fed at school, expect the process to continue at the university. I cannot expand on this theme here, but I would ask any students who may be present to make an effort to find out what facilities their department provides and to make full use of them.

SUMMARY

To summarize then, I should say that I believe that there is a general tendency for universities to assume that they can extrapolate from pre-war conditions. For departments this may be true ; but for the student it is not ; the difference between finding oneself in a class of twelve and a class of forty is important. I believe that the universities must come to recognize this difference, and make more effort than is now done to produce a proper academic atmosphere for the student. If this means soft-pedalling research to some extent, I firmly believe that this will ultimately be good for both the teaching and research of the department.

And I don't think that I can finish on a more cheerful note than that !

Awards to Students

THE following memorandum has been submitted on behalf of the Board of the Institute for consideration by the Government committee, under the chairmanship of Sir Colin Anderson, which is to report on " the present system of awards from public funds to students attending first degree courses at universities and comparable courses at other institutions."

The Institute of Physics is closely interested in the Government's policy relating to maintenance grants from public funds for students in universities and colleges of technology, both as it affects the supply of entrants to the profession of physics and as it affects those members of the Institute who are parents. The Board of the Institute wishes to comment on several aspects of the present policy.

(a) Contributions from Parents

The Committee will be aware of widespread criticism of the so-called " means test," whereby the amount of a student's grant is determined by the income of his parents. The Board desires to express its own criticism of this present position, on the following grounds:

(i) The present scale of parental contributions is such that many parents whose incomes are deemed sufficient to provide the whole, or the major part, of a student's maintenance are, in fact, quite unable to do so without severe hardship to the standard of living, and education, of the rest of the family. Leading industrial members of the Institute, whose firms offer university or other educational facilities, are aware of many such cases. Also, of course, there are parents who are unwilling—although able—to bear the cost of the university education of their children. Many boys and girls of excellent educational background and of good personality, with acceptable university entrance qualifications, are to-day unable to enter universities unless they can obtain financial support from industry or other non-governmental sources where " means tests " do not apply. Some of these students are now following " sandwich " courses for degrees or for the Diploma in Technology and it is, of course, desirable that some should do so. Nevertheless, their choice of career and the method by which they train for it should not be determined simply by the disadvantageous manner in which their parents are affected by government policy. There are other potential university students who, for similar reasons, turn to careers for which university studies are not essential. It is impossible to make numerical estimates but the Board is satisfied that a substantial number of potential scientists of ability are lost to the nation either because parents cannot afford the heavy maintenance contribution expected of them or because the children are unwilling to allow the parents and other children of the family to make the sacrifice that would be needed. It is unnecessary to elaborate upon the conflict between this situation and the frequent official expressions of concern for the maximum utilization of the nation's scientific ability.

(ii) The present high level of direct and indirect taxation is one reason why many parents are unable to provide sufficient financial support for children at universities. By the time that their children are of university age able professional men commonly have incomes of £2,000-£3,000 a year; this is a range in which a parent would be called upon to pay the whole, or almost the whole, of a child's university maintenance. Whatever views may be held upon what they ought to be able to afford, it is a fact that few men in this range of income can find the required money unless they have capital resources. Yet,

additional taxes are levied which presumably help to provide grants to students whose parents have lower incomes. Among professional men there is a widespread sense of injustice based upon the belief that they are subject to double taxation. They pay additional taxes, based upon income, towards grants for which their own children may be ineligible. The Board feels that it may stress this fact because professional physicists are frequently among those most affected.

(iii) Mention is made above of young people who are not prepared to accept sacrifices that their parents would be willing to make. Among such young people, who are often of particularly well-developed personality, a sense of independence is very strong. They are unwilling to be burdens upon their parents and prefer careers that will enable them to avoid such a relationship. If it is in the interest of the community at large that these boys and girls should have university educations if their intellectual abilities merit it, it may equally be felt that the community should provide them *directly* with maintenance, rather than through their parents. Indeed, when they reach the age of 21 years, it is very difficult to justify the present view that they must officially remain financially dependent upon their parents.

(*b*) *Open Awards and State Scholarships*

Whatever may be the official interpretation of local awards as essentially a relief to needy parents from financial responsibility for the education of their children —an interpretation that is not extended to school education—the position of the holder of open awards and to a lesser extent of the State Scholarships could well be separately considered. If these awards were free of limitations because of parental income, at least the worst feature of the present position would be removed. Brilliant children of parents who are neither rich nor poor would not be debarred from full-time university education. Moreover, there is to-day much to be said for tangible recognition of merit.

(*c*) *Uniformity of Grants*

There is variation between the grants of different local bodies for university education and especially for technical education. This is most unfair. A boy's opportunity of education ought not to depend upon the town or county in which his parents live. Authorities also differ in their willingness to support students at universities such as the University College of North Staffordshire where the normal course is of four years duration. Such anomalies should be removed.

(*d*) *Amount of Grant*

In general the maximum grants to undergraduate students seem to us to be quite adequate. Indeed, the view has been expressed that grants sometimes allow students to have a fair amount of luxury. However, although this point may not be within the terms of reference of the present Committee, careful consideration needs to be given to the grants for postgraduate training and research. University physics departments are finding increasing difficulty in attracting their best students to work for higher degrees.

These comments are based upon concern for the maximum entry of suitable children to university courses in science and other subjects, and for the equitable treatment of all children. Our opinion is that the present policy relating to grants is unsatisfactory on both counts. We wish to stress our view that children of parents with incomes similar to those of many professional people are unfairly placed. Government publications contain evidence in support of the view that a child's educational development is significantly affected by the cultural atmosphere of the home in which he grows up. It is not unreasonable to suggest that the children of professional men might be among those best able to profit from university education and that many good scientists might well come from the families of professional scientists. If the nation seriously desires to develop to the full all the latent scientific and other professional talent among its children, the present policy by which the children of professional men are at a disadvantage in securing financial help for further education is not only unjust but profoundly misguided.

Notes and News

Payment of Annual Fees

Members are again asked to co-operate in reducing the cost and labour of collecting fees by using the form printed on page ii. This form is *not* intended for those members who pay fees by bankers' order.

The Institute's 1959 Budget

At its meeting on December 2 the Board approved the budget for 1959 submitted by the Treasurer on behalf of the Finance and General Purposes Committee. The estimates of income and expenditure are about £13,000 up on those estimated for 1958. The total estimated income is £70,650 (compared with £57,100 for 1958) of which £49,550 is expected to come from sales of publications and advertising revenue. This figure compares with £40,000 for 1957. The increased price of the Journal subscriptions should realize about £6,000 and a more favourable advertising contract should increase the advertisement revenue by £3,500. The increase in membership subscription is expected to be about £4,000, mainly due to the increased rates.

As in previous years the two main items of expenditure are £22,000 for production and distribution of publications (excluding staff salaries and overheads) and

£22,500 for salaries, wages, insurance and superannuation. About one third of the latter is attributable to the production and distribution of publications. The cost of the House, including cleaning and caretaking is estimated at about £7,500. Cash grants to Branches and Groups, exclusive of the cost of work done for Branches and Groups and borne on other accounts is £3,100.

A total of £1,580 has been allowed in writing-off the cost of furniture, fittings and alterations and £985 is allowed for the premium on the leasehold redemption policy from which the Institute will receive £40,000 on expiry of the lease of the House.

Convention of Thermonuclear Processes

The Institution of Electrical Engineers has arranged a Convention on Thermonuclear Processes to be held in London on April 29 and 30, 1959. Details of the program have not yet been settled, but the probable range of topics to be covered is as follows : Basic Physics of Thermonuclear Processes ; Prototype British Thermonuclear Experiments—Zeta I, Sceptre III and the Linear Pinch ; Constructional features of Zeta I ; Design Problems in Future Zeta Type Systems; Possibilities of Direct Conversion from Nuclear to Electrical Energy. Reviews of related work in the U.S.A. and the U.S.S.R. will also be included in the program.

Copies of the papes will be available in advance and the complete proceedings of the Convention will be published subsequently in a supplement to the Proceedings of the Institution.

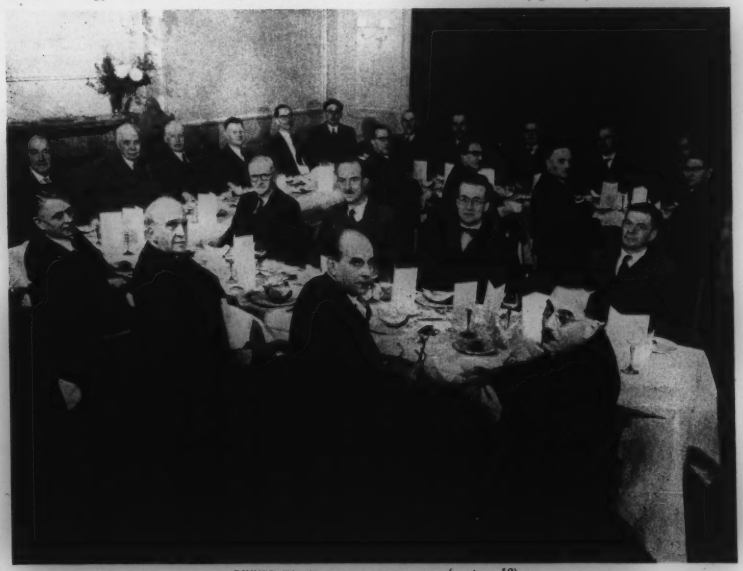
The Convention will be open to members and non-members of the Institution and all wishing to attend will be required to register.

Registration forms are obtainable from the Secretary of the Institution of Electrical Engineers.

Instrumentation and Computation in Process Development and Plant Design

A joint symposium on Instrumentation and Computation in Process Development and Plant Design is to be held at The Central Hall, Westminster, London, S.W.1, on May 11, 12 and 13, 1959. It is being organized by The Institution of Chemical Engineers, The Society of Instrument Technology and The British Computer Society, under the aegis of the British Conference on Automation and Computation.

Full details, including registration fees are available from the Secretary of the Institution of Chemical Engineers, 16 Belgrave Square, London, S.W.1. Forms are to be returned by January 30.



DINNER TO SIR LAWRENCE BRAGG (*see page 12*)

On the outside of the table, beginning at the bottom right-hand corner and reading clockwise : Dr. H. R. Lang, Dr. O. P. T. Kantarowicz, Dr. B. P. Dudding, Prof. A. M. Taylor, Dr. J. Taylor, Sir Lawrence Bragg, Sir George Thomson, Dr. R. W. Sillars, Prof. F. A. Vick, Prof. N. F. Mott, Mr. J. Ratcliffe, Dr. J. Topping, Mr. F. Oldham, Dr. H. H. Hopkins and Dr. J. Thewlis
On the inside of the table, from bottom-right, clockwise : Dr. L. R. G. Treloar, Dr. J. M. A. Lenihan, Dr. D. A. Wright, Prof. W. Sucksmith, Mr. G. W. Warren, Prof. H. Lipson, Dr. M. R. Hopkins and Mr. N. Clarke

Sir Lawrence Bragg (left) and Sir George Thomson

Dinner to Sir Lawrence Bragg

On December 2 members of the Board entertained Sir Lawrence Bragg at an informal dinner and presented to him the Diploma of Honorary Fellowship to which Grade he was elected at the last Annual General Meeting.

Mr. J. A. Ratcliffe (President of The Physical Society) and Professor N. F. Mott (Immediate Past President of The Physical Society) were also guests. Sir George Thomson was in the Chair, and proposed Sir Lawrence's health, mentioning that Sir Lawrence was awarded the Nobel Prize for Physics before he was eligible for admission as M.A.

The occasion was unusual for not only are Sir George Thomson and Sir Lawrence Bragg both Nobel Prize winners, but they are both the sons of Nobel Prize winners. Also they and their fathers are or were Honorary Fellows of the Institute and all have been President of the Institute.

The Institute By-Laws restrict the total number of Honorary Fellows at any time to ten. The present Honorary Fellows are Sir Frank Smith, Professor C. T. R. Wilson, Sir Edward Appleton, Sir Owen Richardson, Professor A. M. Tyndall, Sir James Chadwick, Sir George Thomson and Sir Lawrence Bragg.

Reviews of Books

THEORETICAL ELECTROMAGNETISM

By W. R. Myers

London : Butterworths Scientific Publications. Pp. xi + 274. Price 42s.

This book would be useful for students taking honours physics courses in most universities because it covers a large part of the strictly electrical fields of the subject, although the author stresses in his introduction that relativity and radiation are not treated. Thus for example, aerials are not discussed, a matter of some importance and theoretical interest to the many electrical engineers who will doubtless profit by reading the book. The work is comprehensive, carefully planned, and mathematically is remarkably self contained. The section on propagation in bounded media could, with advantage, be lengthened at the expense of the section on examples in electrostatics. Since a choice of material must, to some extent, always be made in the writing of a book or the preparation of a lecture course, it would seem appropriate for instance to omit mention of the quadrant electrometer in favour of more modern kinds of apparatus. These are not very fundamental criticisms and the book is certainly to be recommended.

There are chapters on electrostatics, magnetostatics, electromagnetic introduction. Maxwell's equation and circuit concepts, electromagnetic waves, examples in electrostatics and there are also some very useful mathematical appendices. The printing and the general preparation of the book are excellent.

J. D. Craggs.

TRANSFORM METHOD IN LINEAR SYSTEM ANALYSIS

By J. A. Aseltine

New York : McGraw-Hill Publishing Co. Pp. xvi + 300. Price 66s.

This book is intended to be a unified presentation of transform methods as applied to various problems in electrical, mechanical and heat theory. The engineer could with advantage use this book for the study of linear differential equations *ab initio*, and it gives an extensive account of the subject with just the amount of rigour that he likes. The author takes the view that the use of non-rigorous mathematical methods is justified if it leads to better understanding and more direct solution of problems, and if the user has knowledge

of their limitations. If his system requires further properties of transforms then it is a problem for a mathematician not an engineer, and in places where there are difficulties reference is made to other sources for rigorous treatment.

The book is well illustrated with diagrams and applications to various engineering systems, etc. There are five chapters dealing with the properties of the Laplace transform, one on the Mellin and one on the Z transforms. Other chapters deal with electrical networks and mechanical systems, random noise, and one discusses the system function (sometimes referred to as the transfer function) and its impulse and frequency responses. An account of the feedback analysis includes a very good brief treatment of the root-locus and Nyquist methods for examining stability. The Z transform is applied to the solution of ladder networks and more generally to difference equations.

Bearing in mind the author's intentions this is altogether an excellent text-book and a worthwhile addition to the Electrical and Electronic Engineering Series of McGraw-Hill.

C. C. RITCHIE.

AN INTRODUCTION TO FLUID DYNAMICS

By G. Temple

London : Oxford University Press. Pp. xi + 195. Price 25s.

This is essentially an account of some of the phenomena in fluid flow for which predictions based on the concept of a perfect fluid are quantitatively adequate for many practical purposes. The book differs from earlier, classical works on Fluid Dynamics by concentrating on types of flow which are actually observed, and by the consequent omission of problems, which, though ingenious, are of mathematical interest only.

The book is written primarily for students reading for Honours in Mathematics and Theoretical Physics and is elementary in the sense that it assumes no previous theoretical knowledge and is confined to the mathematical analysis of a perfect fluid. The pure mathematics necessary for such an investigation is assumed known, and the reader needs to be familiar with vector analysis, including Gauss's and Stokes's theorems, and the elements of complex-function theory. This, combined with careful selection of material and the omission of analytical solutions that are essentially exercises in Pure Mathematics, keeps the book very compact.

The book opens with an interesting radial flow problem. It then derives the equations of continuity, momentum, and energy for a finite mass of fluid, deducing from these the corresponding equations for a "fluid particle." Bernoulli's equation for steady one-dimensional flow is then applied to a diverse selection of problems, such as orifice dampers, ripples and lift on blades in cascade, where reasonable simplifications, coupled with known facts, lead to quantitative results having physical significance. The applications of fundamental principles afforded by these problems completely justify the author's decision to make free use of concepts fully developed later in the book.

The next two chapters deal with the characteristic properties of irrotational motion. They are concerned with fundamental theorems and a detailed consideration of the concept of velocity potential, and its dynamical significance, both for simply—and multiply—connected regions. The application of the complex variable to two-dimensional irrotational motion is concisely developed, and followed by the standard work on point sources, doublets and vortices. There is, however, a non-standard extension to continuous distributions of sources ane vortices along a curve, leading to Green's "equivalent stratum" theorem which is subsequently used to include the total source strength in the Kuta-Joukowski "lift" theorem. Several flow patterns obtained by superposition are investigated, followed by the Blasius and Kutta-Joukowski theorems, and a method for calculating the force on a cylinder in a uniform stream that makes use of the image system. Continuous flow round a flat plate is used to demonstrate the conformal transformation method but discontinuous flow is discussed using Helmholtz's original semi-inverse method. The final chapters cover axisymmetric flow and the approximate theory of flow past a slender body of revolution.

Exercise problems are given at the end of each chapter, and there is a number of references to original papers. Throughout this book great emphasis has been placed on the applications of fundamental principles, and there are frequent and illuminating remarks on the significance of final solutions and of mathematical processes themselves. It undoubtedly provides a sound and interesting introduction to fluid flow for students with a good mathematical background.

G. D. SMITH.

ROBERT BOYLE AND SEVENTEENTH CENTURY CHEMISTRY

By Marie Boas

London : Cambridge University Press. Pp. vii + 240. Price 30s.

At school, we learned that Robert Boyle was "the father of modern chemistry and the seventh son of the Earl of Cork." Professor Boas doubts the exactitude of the former relationship. What she is at pains to show is that Boyle made chemistry respectable. He certainly had much to do with turning chemistry into a branch of physics and some may think that this is the criterion of respectability for any science.

The "philosophers," i.e. physicists, thought little of chemistry in the seventeenth century, partly because it was concerned almost exclusively either with alchemy, or with empirical pharmacology ; and partly because of what Boyle called "the Illiterateness, the Arrogance and the Impostures of too many of those that pretend skill in it."

Boyle did much to remedy this state of affairs. Though he deprecated "mathematizing," this was not so much because he himself lacked mathematical skill as because he was genuinely anxious to be readily understood. Unfortunately, his style of writing was so cumbersome that he did not always succeed in this, and he might have done better had he introduced mathematics into his writings. Although he was never quite certain of the universality of physical properties, which is hardly

surprising considering the standards of purity and accuracy prevalent in his time, he did much to introduce quantitative methodology into chemistry. He was one of the first to believe that synthetic preparations could be identical with natural compounds. Were he alive to-day, he would doubtless be surprised to find that many educated people have still to be convinced of this.

Professor Boas has written a most interesting and well-documented book on seventeenth century chemistry in which Robert Boyle plays a prominent part; but the title of the book should really be inverted. After enjoying this work, one is left with an urge to read a life of Boyle. Apart from a few pages containing a rather inadequate account of his youth and early travels, we hear hardly anything about the man. Thus your reviewer could find only an approximate date for Boyle's birth and no record of his death, nor any mention of such facts as that he never married but lived for much of his life with his sister.

Should this otherwise admirable book run to a second edition, it would be much more interesting if the author could find time to add just a little information about Robert Boyle, the man.

G. W. Scott Blair.

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA (3rd edition)

London : D. Van Nostrand Co. Ltd. Pp. 1839. Price 220s.

For those who are able to spend £11 on nearly 10 lb of printed paper containing 2×10^6 words in one volume, I recommend this work without hesitation. An earlier edition has been a *vade mecum* for me over a long period and rarely has it let me down. The compilers of this third edition have had to wrestle with the remarkable advances in science, engineering and medicine, and the responsibility for the compilation of the data for each of the fields was left largely in the hands of a single contributor in order " to obtain a unity impossible when many men contribute."

There are 100,000 definitions, 14,000 separate articles, 1,400 illustrations and 12 pages of beautiful coloured illustrations. An extensive system of cross indexing is of great help in getting the best out of this tome. Articles dealing with simple concepts are treated generally in simple terms. Others begin with a simple definition and develop the subject, concluding with " a final reflection of the more detailed aspects of the topic treated." The information, so far as casual tests can show, is accurate and up-to-date, although of course not exhaustive in the limited space available. Sampling succeeded in finding most of the topics which have recently made scientific news, including for example the transuranic elements ; but I did not manage to find xerography, exo-electron emission or X-ray fluoroscopic spectroscopy. In the preface, the publishers, contributors and editors ask for " the indulgence of the reader in the case of any significant omissions and in the case of errors" and surely they are entitled to it in such a monumental work. The necessity to make a discriminating selection in order to confine the material within the bounds of even so large a volume must have been very trying and will, I hope, not be necessary in future editions. Two or more volumes of a more manageable size would, in my view, have many advantages—perhaps one for the physical sciences and engineering and another for biology and medicine ; this would enable me, if I were invited to review the next but one edition, to suggest then, that it should be in four volumes. One cannot have too much of good thing.

H. R. Lang.

A DICTIONARY OF NAMED EFFECTS AND LAWS IN CHEMISTRY, PHYSICS AND MATHEMATICS

By D. W. G. Ballentyne and L. E. Q. Walker

London : Chapman and Hall Ltd. Pp. 205. Price 30s.

The intention of the authors of this book is to enable a reader to find out, with a minimum of interruption to his studies, what X's effect or law is ; in this they have succeeded within a limited scope. There are some 800 entries ranging from Abbe's sign condition to the Zeeman effect, each of 50-100 words or so, and " pruned free from historical and other background matter."

It is not clear what terminology has been used in regard to such words as " law," " equation " and " theorem." Thus we find " Bragg equation " for what is often known as " Bragg's law " among crystallographers, and " Joule's law " for the heating effect of a current, often referred to as the " Joule effect." The latter, however, is stated to be the " mechanical change in length when subjected to a magnetic field " which might be regarded as the opposite of the Villari effect. Cross references would be a useful addition.

Although some of the well-known numbers like Reynolds' and Mach's are included there are many others which might be considered for future editions, for example, those bearing the names of Graetz, Grashof, Lewis, Margoulis, Nusselt, Peclet, Prandtl, Schmidt and Stanton.

In an appendix, definitions of 18 units, mostly electrical are given ; why these few should have been selected is not at all clear.

It is a pity that so promising a book should have to be sold at such a high price.

H. R. Lang.

Branch and Group Committees

The Committees of the Institute's Branches and Groups in Great Britain are at present constituted as follows :—

LIVERPOOL AND NORTH WALES BRANCH

Chairman : Mr. F. I. Hurley, F.Inst.P.
Hon. Secretary : Dr. A. Ashmore, A.Inst.P.

Prof. E. R. Andrew, F.Inst.P.
Dr. D. E. C. Corbridge, A.Inst.P.
Prof. J. D. Craggs, F.Inst.P.
Mr. G. C. Eltenton, F.Inst.P.
Dr. P. B. F. Evans, A.Inst.P.
Mr. W. A. Langton, A.Inst.P.
Dr. R. Parker, F.Inst.P.
Dr. G. Parry, A.Inst.P.
Mr. V. W. Rowlands, A.Inst.P.
Prof. H. W. B. Skinner, F.Inst.P., F.R.S.
Mr. H. Tunley, A.Inst.P.

LONDON AND HOME COUNTIES BRANCH

Chairman : Prof. A. M. Taylor, F.Inst.P.
Hon. Secretary : Mr. D. T. R. Dighton, A.Inst.P.

Mr. R. E. Burnett, A.Inst.P.
Mr. F. C. W. Colmer, A.Inst.P.
Mr. B. S. Cooper, F.Inst.P.
Dr. J. S. Forrest, F.Inst.P.
Mr. T. W. Lindop, A.Inst.P.
Mr. T. H. Tyler, F.Inst.P.
Lt.-Col. H. S. Young, F.Inst.P.

MANCHESTER AND DISTRICT BRANCH

Chairman : Prof. H. Lipson, F.Inst.P., F.R.S.
Hon. Secretary : Dr. J. E. Geake, A.Inst.P.

Dr. J. B. Birks, F.Inst.P.
Mr. W. G. Darvell, F.Inst.P.
Mr. J. C. Guthrie, F.Inst.P.
Mr. R. M. Lee, A.Inst.P.
Dr. J. Shaw, A.Inst.P.
Dr. R. W. Sillars, F.Inst.P.
Dr. L. R. G. Treloar, F.Inst.P.

MIDLAND BRANCH

Chairman : Dr. R. E. Bastick, A.Inst.P.
Hon. Secretary : Dr. W. T. Roberts, A.Inst.P.

Mr. M. Bridger, A.Inst.P.
Mr. M. A. Cayless, A.Inst.P.
Mr. R. F. Coe, A.Inst.P.
Dr. J. H. Davis, F.Inst.P.
Mr. T. A. Eames, F.Inst.P.
Mr. W. C. Hynd, A.Inst.P.
Prof. P. B. Moon, F.Inst.P., F.R.S.
Mr. R. R. Osborne, A.Inst.P.
Dr. L. Riddiford, F.Inst.P.
Mr. V. Roberts, F.Inst.P.
Dr. E. Robinson, F.Inst.P.

NORTH-EASTERN BRANCH

Chairman : Dr. O. P. T. Kantorowicz, F.Inst.P.
Hon. Secretary : Dr. W. D. Corner, F.Inst.P.

Prof. W. E. Curtis, F.Inst.P., F.R.S.
Mr. W. R. Eadington, Grad.Inst.P.
Mr. T. E. Heslop, A.Inst.P.
Mr. K. E. Pattinson, A.Inst.P.
Mr. G. N. Peel, F.Inst.P.
Prof. G. D. Rochester, F.Inst.P., F.R.S.
Dr. N. Thorley, F.Inst.P.

SCOTTISH BRANCH

Chairman : Mr. R. M. Sillitto, F.Inst.P.
Hon. Secretary : Dr. A. R. Boyle, A.Inst.P.

Dr. A. F. Brown, A.Inst.P.
Dr. W. G. Ferrier, A.Inst.P.
Dr. J. M. A. Lenihan, F.Inst.P.
Mr. D. M. McCall, A.Inst.P.
Mr. A. S. McLaren, A.Inst.P.
Mr. T. R. Prentice, A.Inst.P.
Dr. D. H. Pringle, A.Inst.P.
Mr. H. L. D. Pugh, F.Inst.P.
Dr. J. G. Rutherglen, A.Inst.P.
Mr. J. W. Sharpe, F.Inst.P.
Dr. T. Smith, A.Inst.P.
Dr. J. M. Valentine, F.Inst.P.
Dr. G. A. P. Wyllie, F.Inst.P.
Mr. J. C. Young, A.Inst.P.

SOUTH WALES BRANCH

Chairman : Dr. M. R. Hopkins, F.Inst.P.
Hon. Secretary : Dr. H. O. Puls, F.Inst.P.

Dr. G. O. Forester, A.Inst.P.
Mr. L. R. Griffin, A.Inst.P.
Mr. R. E. James, A.Inst.P.
Mr. I. C. Jones, F.Inst.P.
Prof. F. C. Llewellyn-Jones, F.Inst.P.
Dr. W. Mervyn Jones, F.Inst.P.
Mr. W. J. Lewis, F.Inst.P.
Dr. D. Rogers, F.Inst.P.
Dr. T. S. P. Tuck, A.Inst.P.
Dr. G. Williams, F.Inst.P.
Prof. A. J. C. Wilson, F.Inst.P.
Mr. R. G. Wood, F.Inst.P.

SOUTH-WESTERN BRANCH

Chairman : Prof. S. H. Piper, F.Inst.P.
Hon. Secretary : Dr. S. H. Ayliffe, A.Inst.P.

Dr. K. E. Grew, F.Inst.P.
Mr. H. F. T. Jarvis, A.Inst.P.
Dr. C. F. Sharman, F.Inst.P.
Dr. H. A. Standing, F.Inst.P.
Dr. N. Thompson, F.Inst.P.
Prof. A. J. Woodall, F.Inst.P.
Dr. M. L. Wright, A.Inst.P.

YORKSHIRE BRANCH

Chairman : Prof. W. Sucksmith, F.Inst.P., F.R.S.
Hon. Secretary : Dr. M. McCaig, F.Inst.P.

Dr. K. W. Andrews, F.Inst.P.
Mr. B. Bradley, A.Inst.P.
Dr. A. B. D. Cassie, F.Inst.P.
Dr. A. Cunliffe, A.Inst.P.
Dr. G. M. Leak, F.Inst.P.
Mr. W. C. Potts, F.Inst.P.
Dr. E. F. W. Seymour, A.Inst.P.
Dr. D. L. Smare, F.Inst.P.
Dr. R. S. Tebble, F.Inst.P.

APPLIED SPECTROSCOPY GROUP

Chairman : Dr. A. C. G. Menzies, F.Inst.P.
Hon. Secretary : Mr. F. W. J. Garton, A.Inst.P.

Mr. A. Argyle
Dr. G. H. Beaven
Mr. L. Brealey
Dr. L. F. H. Bovey, A.Inst.P.
Mr. M. Milbourn, F.Inst.P.
Mr. D. M. Smith, F.Inst.P.
Mr. J. R. Stansfield, F.Inst.P.
Mr. E. H. S. van Someren, F.Inst.P.

EDUCATION GROUP

Chairman : Mr. G. W. Warren, F.Inst.P.
Hon. Secretary : Mr. T. H. Tyler, F.Inst.P.

Mr. M. H. H. Bunton, A.Inst.P.
Mr. B. Holmes, A.Inst.P.
Dr. E. J. Irons, F.Inst.P.
Mr. E. Nightingale, F.Inst.P.
Mr. D. J. Pacey, A.Inst.P.
Miss K. E. Parks, A.Inst.P.
Dr. N. Pentland, F.Inst.P.
Dr. M. Pillow, F.Inst.P.
Mr. F. Y. Poynton, F.Inst.P.
Dr. R. F. Y. Randall, F.Inst.P.
Mr. H. P. Rooksby, F.Inst.P.
Dr. N. Thompson, F.Inst.P.
Prof. A. J. Woodall, F.Inst.P.

ELECTRONICS GROUP

Chairman : Dr. M. E. Haine, F.Inst.P.
Hon. Secretary : Dr. C. A. Hogarth, F.Inst.P.

Mr. A. G. I. Cressel, A.Inst.P.
Dr. G. Francis, A.Inst.P.
Dr. K. Hoselitz, F.Inst.P.
Mr. J. H. Jones, F.Inst.P.
Mr. J. Pollard, A.Inst.P.
Dr. T. B. Rymer, F.Inst.P.
Mr. L. A. Thomas, F.Inst.P.
Dr. J. S. Thorp, A.Inst.P.

ELECTRON MICROSCOPY GROUP

Chairman : Dr. J. W. Menter, F.Inst.P.
Hon. Secretary : Mr. A. W. Agar, F.Inst.P.

Dr. J. A. Chapman, A.Inst.P.
Dr. A. M. Glauert
Mr. T. Mulvey
Mr. R. S. M. Revell, A.Inst.P.
Mr. J. W. Sharpe, F.Inst.P.
Dr. J. Sikorski, A.Inst.P.

NON-DESTRUCTIVE TESTING GROUP

Chairman : Mr. B. R. Byrne
Hon. Secretary : Mr. R. S. Sharpe, A.Inst.P.

Prof. C. B. Allsopp, F.Inst.P.
Mr. B. D. Burns, A.Inst.P.
Dr. A. E. Calnan, F.Inst.P.
Mr. W. G. Cook
Mr. R. de P. B. Daubeny
Mr. E. J. Grimwade
Dr. R. H. Herz, F.Inst.P.
Prof. R. King, A.Inst.P.
Dr. G. M. Leak, F.Inst.P.
Dr. P. Lord, A.Inst.P.
Dr. R. W. Powell, F.Inst.P.
Mr. W. E. Schall, F.Inst.P.
Dr. E. G. Stanford, F.Inst.P.
Dr. J. Thewlis, F.Inst.P.

STRESS ANALYSIS GROUP

Chairman : Mr. B. Sugarman, F.Inst.P.
Hon. Secretary : Mr. V. M. Hickson, A.Inst.P.

Mr. A. F. Appleton
Mr. A. F. C. Brown
Miss M. W. Clutterbuck, A.Inst.P.
Dr. H. Fessler
Mr. E. K. Frankl
Mr. M. L. Meyer
Mr. C. D. Pomeroy, A.Inst.P.
Mr. W. H. Ray
Mr. C. Snell

X-RAY ANALYSIS GROUP

Chairman : Prof. E. G. Cox, F.Inst.P., F.R.S.
Hon. Secretary : Dr. R. L. Gordon, F.Inst.P.

Dr. E. Aruja, A.Inst.P.
Dr. C. W. Bunn, F.Inst.P.
Prof. Sir Lawrence Bragg, Hon.F.Inst.P., F.R.S.
Dr. E. A. Calnan, F.Inst.P.
Dr. P. T. Davies, A.Inst.P.
Dr. A. Franks, A.Inst.P.
Prof. H. Lipson, F.Inst.P., F.R.S.
Dr. H. D. Megaw, F.Inst.P.
Dr. B. M. Oughton
Dr. P. G. Owston
Dr. D. Rogers, F.Inst.P.
Dr. J. C. Speakman
Dr. E. G. Steward, F.Inst.P.
Dr. J. Thewlis, F.Inst.P.
Dr. R. F. Youell, A.Inst.P.

Forthcoming Institute Meetings

THE following is the list of Institute meetings so far arranged for the second half of the 1958-59 session. Members of all grades may attend any of the meetings whether or not they belong to the Branch or Group concerned. Where it is indicated that tickets or application forms are necessary early application should be made.

Date	*Place*	*Speaker*	*Title*	*Time*	*Branch or Group*
Jan. 12	**Edinburgh** The University	Dr. R. Q. Twiss	**Correlation between photons and applications to astronomy**	7.15 p.m.	Scottish
Jan. 13	**St. Andrews** The University	Dr. R. Q. Twiss	**Correlation between photons and applications to astronomy**	7.15 p.m.	Scottish
Jan. 14	**London** The Royal Institution	The President of the Institute, Sir George Thomson, Hon.F.Inst.P., F.R.S.	**Controlled thermonuclear reactions**	5.30 p.m.	London and Home Counties
	Admission is by ticket only ; all tickets now issued.				
Jan. 15	**Glasgow** The University	Dr. R. Q. Twiss	**Correlation between photons and applications to astronomy**	7.15 p.m.	Scottish
Jan. 16	**Bristol** The University	Prof. F. W. Spiers (*University of Leeds*)	**Biological hazards of radiation**	7.00 p.m.	South Western
Jan. 16	**London** The Horse Shoe Hotel, Tottenham Court Road	Mr. S. Rees Jones, F.Inst.P. (*Courtauld Institute of Art, London*)	Group Dinner Meeting followed by : **Testing of works of art and the detection of forgeries**	6.30 p.m. for 7.00 p.m.	Non-Destructive Testing
	Admission by ticket only. Primarily for Non-Destructive Testing Group members and their ladies.				
Jan. 19	**Manchester** The University	Prof. R. W. Ditchburn, F.Inst.P. (*University of Reading*)	**Eye movements and visual perception**	6.45 p.m.	Manchester and District
Jan. 20	**London** The Institute's House	Dr. H. J. Goldsmid (*Research Laboratories, The General Electric Co. Ltd., Wembley*)	**Thermoelectric devices**	5.30 p.m.	Electronics
Jan. 20	**Gosta Green** Birmingham College of Technology	The President of the Institute, Sir George Thomson, Hon.F.Inst.P., F.R.S.	**Sir J. J. Thomson**	6.30 p.m.	Midland
Jan. 21	**London** The Institute's House	Dr. J. Topping, F.Inst.P. (*Brunel College of Technology, Acton*) Professor A. J. Woodall, O.B.E., F.Inst.P. (*Royal Military College of Science, Shrivenham*)	**A discussion on scientific method**	6.00 p.m.	Education
Jan. 22 and 23	**London** The Institution of Civil Engineers		**Symposium on Nuclear Fuel Cycles**		
	Details and application forms can be obtained from the Secretary of the Institute.				
Jan. 27	**Glasgow** The University	Dr. R. D. Keynes (*University of Cambridge*)	**Transmission of electrical impulses along nerve fibres**	7.15 p.m.	Scottish
Jan. 28	**Dundee** Queen's College	Dr. R. D. Keynes (*University of Cambridge*)	**Transmission of electrical impulses along nerve fibres**	5.00 p.m.	Scottish
Jan. 30	**Newcastle-upon-Tyne** King's College	Dr. G. W. Series (*Clarendon Laboratory, University of Oxford*)	**The spectrum of atomic hydrogen**	6.15 p.m.	North Eastern
Feb. 3	**Edinburgh** The University	Dr. K. Hoselitz, F.Inst.P. (*Mullard Research Laboratory, Salfords*)	**Research problems in ferrites**	7.15 p.m.	Scottish
Feb. 4	**Sheffield** The University	Prof. R. W. Douglas, F.Inst.P. (*University of Sheffield*)	**Some topics in the physics of glass**	5.00 p.m.	Yorkshire
Feb. 4	**Aberdeen** The University	Dr. K. Hoselitz, F.Inst.P. (*Mullard Research Laboratory, Salfords*)	**Research problems in ferrites**	7.15 p.m.	Scottish
Feb. 9	**Glasgow** The University	Dr. J. D. Lawson (*Atomic Energy Research Establishment, Harwell*)	**Recent developments in particle accelerators**	7.15 p.m.	Scottish

Date	*Place*	*Speaker*	*Title*	*Time*	*Branch or Group*
Feb. 10	**Edinburgh** The University	Dr. J. D. Lawson (*Atomic Energy Research Establishment, Harwell*)	**Recent developments in particle accelerators**	7.15 p.m.	Scottish
Feb. 11	**Dounreay** Pentland Hotel Thurso	Dr. J. D. Lawson (*Atomic Energy Research Establishment, Harwell*)	**Recent developments in particle accelerators**	7.30 p.m.	Scottish
Feb. 11	**London** The Institute's House	Prof. H. Lipson, F.Inst.P., F.R.S. (*Manchester College of Science and Technology*)	**What is a physicist ?**	6.00 p.m.	Education
Feb. 12	**Liverpool** The University	Dr. W. H. Evans, A.Inst.P. (*University of Liverpool*)	**Bubble Chambers**	7.00 p.m.	Liverpool and North Wales
Feb. 12	**Rugby** British Thomson Houston Laboratories	Prof. F. A. Vick, O.B.E., F.Inst.P. (*University College of North Staffordshire, Keele*)	Visit to laboratories followed by a talk on : **The field emission of electrons**	2.30 p.m.	Midland
Feb. 13	**London** The Institute's House	Dr. H. Kolsky, F.Inst.P. (*Atomic Research Development Establishment, Fort Halstead*)	**Stress waves in solids**	6.00 p.m.	Non-Destructive Testing
Feb. 13	**Exeter** The University	Dr. W. Grey Walter (*Burden Neurological Institute*)	**Mind the machine—the cybernetic approach to mentality and society**	7.00 p.m.	South Western
Feb. 13	**Cardiff** University College	Dr. L. Fox (*Oxford University Computing Laboratory*)	**Scientific uses of digital computers**	5.15 p.m.	South Wales
Feb. 16	**Manchester** The University	Dr. E. C. Cherry (*Imperial College of Science and Technology, London*)	Branch Annual General Meeting followed by a talk on : **The origins, ideas and applications of information theory**	6.30 p.m. 7.00 p.m.	Manchester and District
Feb. 17	**London** The Institute's House	Dr. S. Kaufman (*Associated Electrical Industries Research Laboratory, Aldermaston*)	**Experimental observations of a highly ionized gas**	5.30 p.m.	Electronics
Feb. 18	**London** The Institute's House	Prof. J. D. Bernal, F.Inst.P., F.R.S. (*Birkbeck College, London*)	**The theory of liquids**	6.00 p.m.	London and Home Counties
Feb. 20	**London** The Institute's House	Mr. F. W. J. Garton, A.Inst.P. (*United Kingdom Atomic Energy Authority, Research Group, Woolwich*) Mr. R. A. Mostyn (*Chemical Inspectorate, Ministry of Supply, Woolwich*) Dr. R. L. Mitchell, (*Macaulay Institute for Soil Research, Aberdeen*) Mr. M. Ward, (*Pilkington Brothers Limited, St. Helens*) Mr. G. Kingsbury (*Chemical Research Laboratory, Teddington*) and others.	A Colloquium on **Spectrochemical analysis of powders**	3.00 p.m.	Applied Spectroscopy
Feb. 24	**Edinburgh** The University	Dr. L. R. G. Treloar, F.Inst.P. (*British Rayon Research Association, Manchester*)	**Rubber and the rubber-like-state**	7.15 p.m.	Scottish Branch
Feb. 25	**Dundee** Queen's College	Dr. L. R. G. Treloar, F.Inst.P. (*British Rayon Research Association, Manchester*)	**Rubber and the rubber-like-state**	5.00 p.m.	Scottish
Mar. 3	**Glasgow** The University	Prof. E. R. Andrew, F.Inst.P., F.R.S.E. (*University College of North Wales*)	**Recent advances in nuclear magnetic resonance**	7.15 p.m.	Scottish

Date	*Place*	*Speaker*	*Title*	*Time*	*Branch or Group*
Mar. 4	**Aberdeen** Marischall College	Prof. E. R. Andrew, F.Inst.P., F.R.S.E., (*University College of North Wales*)	**Recent advances in nuclear magnetic resonance**	7.15 p.m.	Scottish
Mar. 4	**London** The Institute's House		Group Annual General Meeting	5.00 p.m.	Education
		Mr. C. A. Ronan, F.R.A.S. (*The Royal Society, London*)	**Some aspects of the international geophysical year**	6.00 p.m.	
Mar. 6	**Bristol** The University		Branch Annual General Meeting	6.15 p.m.	South Western
		Prof. C. B. Allsopp, F.Inst.P. (*Guy's Hospital Medical School, London*)	**Physics in the investigation of crime**	7.00 p.m.	
Mar. 11	**Leeds** The University	Mr. H. W. French, F.Inst.P.	Branch Annual General Meeting followed by a lecture on **Physics and musical syntheses**	5.00 p.m.	Yorkshire
Mar. 12	**Liverpool** The University	Mr. O. W. Humphreys C.B.E., F.Inst.P. (*Research Laboratories of The General Electric Co. Ltd., Wembley*)	To be announced	7.00 p.m.	Liverpool and North Wales
Mar. 13	**Sheffield**	Prof. G. A. Homès (*Polytechnic Faculty, Mons, and University of Brussels*)	**The physical background of existing techniques and the relationships between physical and structural properties**		Non-Destructive Testing
		Time and place to be announced			
Mar. 13	**Swansea** University College	Prof. W. E. Lamb, F.Inst.P. (*University of Oxford*)	**Molecular amplifiers and oscillators**	5.15 p.m.	South Wales
Mar. 16	**Manchester** The University	Dr. A. G. Gaydon, A.Inst.P., F.R.S. (*Imperial College of Science and Technology, London*)	**Recent developments in techniques for the spectroscopy of flames**	6.45 p.m.	Manchester and District
Mar. 17	**London** The Institute's House		Group Annual General Meeting	5.30 p.m.	Electronics
		Dr. E. G. S. Paige (*Royal Radar Establishment, Malvern*)	**Electrical effects of dislocations in silicon and germanium**	5.40 p.m.	
Mar. 18	**Birmingham** The University	Prof. J. B. Bernal, F.Inst.P., F.R.S. (*Birckbeck College, London*)	**The physical basis of life**	6.30 p.m.	Midland
Mar. 19	**London** The Institute's House	Prof. O. R. Frisch, F.R.S. (*Cavendish Laboratory, University of Cambridge*)	**The new particles of physics**	6.00 p.m.	London and Home Counties
Mar. 19	**Newcastle-upon-Tyne** King's College	Mr. I. M. Ross (*Services Electronics Research Laboratory, Harlow*)	**Masers and reactance amplifiers**	6.15 p.m.	North Eastern
Mar. 31 to Apr. 4	**Delft** Netherlands Technische Hogeschool		**A conference in collaboration with the Instituut T.N.O.**		Stress Analysis
		The conference is open to all interested, but registration is necessary. Details and application forms can be obtained from the Secretary of the Institute.			
April (date to be announced)			Half-day meeting on : **Strain measurement at elevated temperature**		Stress Analysis
April 2 and 3	**London** The Institute's House		Easter Conference on : **Teaching of science to children up to the age of fifteen**		Education
		Registration is necessary and attendance is limited. Further details will be circulated to Education Group members and may be obtained by others from the Secretary of the Institute.			
April 9	**Liverpool** The University	Dr. N. Kurti, F.Inst.P., F.R.S. (*Clarendon Laboratory, (The University of Oxford*)	**Nuclei at very low temperatures**	7.00 p.m.	Liverpool and North Wales
April 10	**London** The Institution of Electrical Engineers	Chairman : Dr. C. C. Sykes, C.B.E., F.Inst.P., F.R.S., with a number of invited speakers to open the discussion	Open discussion on : **What industry requires from non-destructive testing**	2.30 p.m.	Non-Destructive Testing

Date	*Place*	*Speaker*	*Title*	*Time*	*Branch or Group*
April (Date to be announced)	**Birmingham** The University	Further details will be sent to Midland Branch members.	**Branch Annual Dinner**	To be announced	Midland
April 14	**Isleworth Middlesex**	Mr. I. Evans, F.Inst.P. (*Central Research Establishment, Isleworth*)	Visit to the Mining Research Establishment, followed by a lecture on **The fracture of brittle materials**	2.15 p.m. 5.45 p.m.	London and Home Counties
	Registration is necessary and attendance is limited. Further details will be circulated to London and Home Counties Branch members and may be obtained by others from the Secretary of the Institute.				
April 17 and 18	**Leeds** The University		Spring Conference on **Clay minerals and Biological Fibres.** The first session will be preceded by the Group Annual General Meeting		X.Ray Analysis
	Visitors are welcome but registration is necessary. Further details will be sent to X-ray Analysis Group members about the beginning of March and will be available to others on application to the Secretary of the Institute. Enquiries regarding the programme should be addressed to the Honorary Conference Secretary, Dr. R. F. Youell, Department of Physics, The University, Leeds, 2.				
April 21	**Stoke** British Ceramic Research Association		Visit to laboratories followed by a talk (to be arranged)	2.30 p.m.	Midland
April 24	**Aberystwyth** University College of Wales	Dr.C.E.Wynn-Williams (*Imperial College of Science and Technology, London*)	**An introduction to electrical logic**	5.15 p.m.	South Wales
May 5	**London** Park Lane Hotel		**Institute Annual Dinner** Details to be announced		
May 8	**London** The Institute's House		An all-day Symposium on : **Reviews of recent developments in Spectroscopy**	11.30 a.m.	Applied Spectroscopy
		Dr. L. F. H. Bovey, A.Inst.P. (*Atomic Energy Research Establishment, Harwell*)	**Atomic Spectroscopy**		
		Prof. W. C. Price, F.Inst.P. (*King's College, London*)	**Molecular Spectrocopy**		
		Mr. W. Ramsden (*Aluminium Research Laboratories (Gt. Britain) Ltd.*	**Spectrochemical analysis**		
		Dr. A. C. G. Menzies, F.Inst.P., F.R.S.E., (*Hilger & Watts Ltd., London*)	**Instrumentation**		
		Dr. D. J. E. Ingram, F.Inst.P. (*University of Southampton*)	**Magnetic resonance at radio and micro-wave frequencies**		
May 8	**London** The Institute's House	Dr. W. R. Harper, F.Inst.P. (*Imperial College of Science and Technology, London*)	**The tribo-electric effect**	6.00 p.m.	Non-Destructive Testing
May 14	**Liverpool** The University	Mr. J. M. Craddock (*Meteorological Office*)	Branch Annual General Meeting followed by a lecture on : **Long range weather forecasting**	7.00 p.m.	Liverpool and North Wales
June — (Date, place and further details to be announced)			Summer meeting with members of Gesellschaft zur Förderung Zerslörungsfreier Prüfverhahren		Non-Destructive Testing
June 2 (tentative)	**Hailsham Sussex**		Branch summer visit to the Royal Greenwich Observatory, Hurstmonceux Castle. Details will be circulated later to Branch members.		London and Home Counties
June 19	**Shrivenham** College of Science	Dr.C.E.Wynn-Williams (*Imperial College of Science and Technology, London*)	Visit to the Royal Military College of Science, followed by a lecture on : **An introduction to electrical logic**		South Western
			Full details will be announced later		
July 6 to 10	**Exeter** The University		Annual Group Conference		Electron Microscopy
			Full details will be sent to Electron Microscopy Group members		
July 18	**Cambridge**		Summer meeting and visit to the Cavendish Laboratory		Education
			Primarily for members of the Group and their guests. Registration is necessary and details will be sent to Education Group members about the beginning of June		

The Register

ELECTIONS TO MEMBERSHIP

THE FOLLOWING ELECTIONS WERE MADE BY THE BOARD ON DECEMBER 2, 1958

An asterisk (*) indicates transfer from another grade

FELLOWS

*Douglas, Alexander Shafto, B.A., Ph.D., Director, Electronic Computing Laboratory, University of Leeds.

*Franks, Joseph, B.Sc., Ph.D., Section Leader, Siemens Edison Swan Ltd., Harlow, Essex.

*Froome, Keith Davy, B.Sc., Ph.D., Senior Principal Scientific Officer, National Physical Laboratory, Teddington, Middx.

Godfrey, Derrick Edward Reid, M.Sc., Ph.D., Head of Mathematics Department, Woolwich Polytechnic.

*Hall, Eric Ogilvie, M.Sc., Ph.D., Associate Professor of Metallurgy, University College of New South Wales, Australia.

*Hamstead, George William, B.Sc., A.R.C.S., Technical and Research Manager, W. Watson & Sons Ltd., Barnet, Herts.

*Henisch, Heinz Kurt, B.Sc., Ph.D., Lecturer, University of Reading.

*Jain, Suresh Chand, M.Sc., Ph.D., I.C.I. Fellow, University of Leeds.

*Lock, William Owen, B.Sc., Ph.D., Lecturer, University of Birmingham.

*Macdonald, Simon Gavin George, M.A., Ph.D., Senior Lecturer, University College of the West Indies, Jamaica.

*Morris, George William Alfred, B.Sc., Principal Scientific Officer, Admiralty Research Laboratory, Teddington, Middx.

Owen, Benjamin Glydwr, B.Sc., Ph.D., Research Manager, U.K. Atomic Energy Authority, Dounreay, Scotland.

*Roulston, Kenneth Irwin, B.A., M.Sc., Ph.D., Associate Professor of Physics, University of Manitoba, Canada.

*Ward, Alan Howard, B.Sc., Ph.D., Senior Lecturer, University College of Ghana.

*Watson, Peter Ewart, M.A., Research Manager, Laporte Titanium Ltd., Luton, Beds.

*Wright, Raymond William Henry, B.Sc., Ph.D., Professor of Physics, University College of Ghana.

ASSOCIATES

*Adams, Kenneth Henry James, B.Sc., Departmental Head, Mullard Radio Valve Co. Ltd., Mitcham, Surrey.

Aubrey, Kenneth Vivian, B.Sc., Principal Scientific Officer, Fuel Research Station, D.S.I.R., Greenwich, London.

*Barlow, Graham Stewart, B.Sc., Ph.D., Assistant Master, The Gateway School for Boys, Leicester.

*Baynes, Frederick, Technical Development Manager, Dunlop Footwear Co. Ltd., Speke, Liverpool.

Benson, Anthony Carruthers, B.Sc., Ph.D., Lecturer in Building Science, University of Liverpool.

*Brindley, Charles Edwin, B.Sc., Physicist, U.K. Atomic Energy Authority, Capenhurst, Chester.

Brymner, Robert, B.Sc., Physicist, Edwards High Vacuum Ltd., Crawley, Sussex.

Chapman, Andrew Colin, B.Sc., Ph.D., Physicist, Albright & Wilson (Mfg.) Ltd., Oldbury, Birmingham.

Cooper, James Campbell, B.Sc., Senior Science Master, Woodhouse Grammar School, Sheffield.

*Dally, Cyril William, B.Sc., Senior Physics Master, Woodley Hill Grammar School, Berks.

*Davies, Brian Leonard, B.Sc., Senior Physicist, Powers Samas Accounting Machines Ltd., Research Establishment, Whyteleafe, Surrey.

Deshpande, Vishnupant, M.Sc., Ph.D., Reader, University of Osmania, Hyderabad, India.

*Fletcher, Raphael Oswald Wiltshire, M.Sc., Temporary Master, Tulse Hill School, London.

*Hansford, Ian Victor, B.Sc., Project Leader, Vickers Group Research Establishment, Weybridge, Surrey.

*Hatherton, Trevor, B.Sc., Ph.D., Principal Scientific Officer, D.S.I.R., Wellington, New Zealand.

*Heywood, Peter John, B.Sc., Senior Quality Engineer, De Havilland Propellers Ltd.

Jackson, George, B.Sc., Physicist, U.K. Atomic Energy Authority, Windscale Works, Cumberland.

*James, Denison Alfred, B.Sc., Senior Lecturer, Royal Military College of Science, Shrivenham, Wilts.

Jones, John Goranwy, M.Sc., Senior Physics Master, Canon Slade School, Bolton, Lancs.

*Jones, Maurice Joseph, B.Sc., Physicist, The General Electric Co. Ltd., Wembley, Middx.

*Kellett, Ernest Arthur, B.Sc., Scientific Staff, The General Electric Co. Ltd., Wembley, Middx.

*Laker, William Eric, B.Sc., Physicist, Bristol Aero-Engines Ltd., Filton House, Bristol.

Lambourn, Brian David, B.Sc., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.

*Main, Iain Grant, B.Sc., M.A., Shell Oil Fellow, Queen's University, Ontario, Canada.

Massey, William Joseph Grenville, B.Sc., Senior Physics Master, City Grammar School, Sheffield.

*May, Douglas, B.Sc., Research Physicist, Glass Yarns & Deeside Fabrics Ltd., Blackwater, Lancs.

*Morrison, Eric James Watson, B.Sc., Project Engineer, J. Stone & Co. (Deptford) Ltd., Crawley, Sussex.

*Morgan, Thomas Roger, B.Sc., Senior Scientific Officer, Royal Naval Scientific Service.

*Muff, Peter, B.Sc., Physicist, Electric & Musical Industries Ltd., Hayes, Middx.

*Parker, John Joseph, B.Sc., Research Physicist, Dunlop Rubber Co. Ltd., Birmingham.

*Rees, Brian Llewelyn, B.Sc., Technical Officer, British Nylon Spinners Ltd., Pontypool, Mon.

Reid, Albert Douglas, B.Sc., Physicist, U.K. Atomic Energy Authority, Capenhurst Works, Chester.
*Riley, Robert, B.Sc., Lecturer, Municipal Technical College, Oldham, Lancs.
*Roycroft, Donald Martin, B.Sc., Technologist, Shell Refining & Marketing Co. Ltd., Ellesmere Port, Cheshire.
Sister St. Joan of Arc, B.Sc., Senior Science Mistress, La Retraite High School, Clifton, Bristol.
*Saunders, John Walter, B.Sc., A.R.C.S., Research Engineer, Electric & Musical Industries Ltd., Hayes, Middx.
*Seymour, John, B.Sc., Senior Valve Engineer, Standard Telephone & Cables Ltd., Footscray, Kent.
Shilton, Arthur, M.Sc., Lecturer, Brighton Technical College, Sussex.
*Skertchly, Allan, M.Sc., Assistant Lecturer, University of Leeds.
*Smith, Eric James, Process Control Manager, Dunlop Rubber Co. Ltd., Speke, Liverpool.
*Smith, William Arthur, B.Sc., Ph.D., Scientific Officer, U.K. Atomic Weapons Research Establishment, Foulness, Essex.
*Taylor, Gordon William, M.Sc., A.R.C.S., Principal Scientific Officer, Ministry of Supply, A.T.D.U., Helston, Cornwall.
*Thompson, Brian John, B.Sc., Assistant Lecturer, College of Science & Technology, Manchester.
Wesson, John Alan, B.Sc., Research Physicist, Associated Electrical Industries Research Laboratory, Aldermaston, Berks.
White, Douglas Francis, B.Sc., A.R.C.S., Physicist, Ekco Electronics Ltd., Southend-on-Sea, Essex.
Wratten, Raymond Clifford, B.Sc., Senior Engineer, Tube Investment Technological Centre, Walsall, Staffs.
*Zarzycki Janusz, M.Sc., Lecturer, Borough Polytechnic, London.

GRADUATES

Allnutt, Lawrence Andrew, B.Sc., Temporary Assistant Experimental Officer, National Physical Laboratory, Teddington, Middx.
Andrews, Richard Charles, M.Sc., Physicist, Chance Bros., Ltd., Birmingham.
Armstrong, Wallace Elliott, M.Sc., Physicist, Wellington Hospital, New Zealand.
Bailey, Peter Anthony, B.Sc., Physicist, British Oxygen Research & Development Co. Ltd., London.
Barrett, Paul Robert, B.Sc., Research Student, University of Birmingham.
Blakely, John McDonald, B.Sc., Research Student, University of Glasgow.
Booth, George Anthony, B.Sc., Assistant Experimental Officer, U.K. Atomic Energy Authority, Windscale Works, Cumberland.
Chatfield, Eric John, B.A. Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.
Claxton, Keith Thomas, B.Sc., Research Student Imperial College of Science & Technology, London.
Pitt-Cooper, William Marcus, B.Sc., Temporary Teacher, Cornwall Technical College.
Davies, Eirwyn, B.Sc., Scientist, National Coal Board, Mining Research Establishment, Isleworth, Middx.
Davies, Paul, B.Sc., A.R.C.S., Research Student, Imperial College of Science & Technology, London.
Denham, David, B.Sc., Research Student, University of Leeds.
Foxell, Clive Arthur Peirson, B.Sc., Physicist, The General Electric Co. Ltd., Wembley, Middx.
Foy, Barbara Jessie, B.Sc., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.
Gould, Stanley Samuel, B.A., Technical Officer, British Nylon Spinners Ltd., Pontypool, Mon.
Gray, John Gregory Hayman, B.Sc., Assistant Technical Officer, Imperial Chemical Industries Ltd., Welwyn Garden City, Herts.
*Greenfield, Ralph Charles, B.Sc., Scientist, Kodak Ltd., Wealdstone, Middx.
Harris, Morlais John, B.Sc., Scientific Officer, U.K. Atomic Energy Authority, Seascale, Cumberland.
*Harrison, Ronald Maurice, B.Sc., Research Student, Queen Mary College, London.
Howson, Ronald Philip, B.Sc., Research Student, University of Exeter.
*Jaggers, Anthony John, A.R.C.S., Assistant Experimental Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.
Jones, Keith Albert George, B.Sc., Scientist, National Coal Board, Cheltenham, Glos.
Keen, Colin Geoffrey, B.A., Assistant Experimental Officer, U.K. Atomic Energy Authority.
Lambert, Kevin Michael, B.Sc., Student, Department of Education, University of Leeds.
*Law, Roy, B.Sc., Postgraduate Student, Imperial College of Science & Technology, London.
Linington, Alfred William, B.Sc., Junior Engineer, A. V. Roe & Co. Ltd., Chertsey.
Macefield, Brian Edward Frederick, B.A., Scientific Officer, Atomic Weapons Research Establishment, Aldermaston, Berks.
Martin, Peter Humphery, B.Sc., Assistant Lecturer, Brighton Technical College, Sussex.
Munro, Ian Hyslop, B.Sc., Research Student, University of Manchester.
Nicholas, Roger Harold, B.Sc., Research Assistant, Hilger & Watts Ltd., London.
*Pugh, Aled Rees, B.Sc., Flight Test Observer, Handley Page Ltd., St. Albans, Herts.
Quinn, Terence Frederick James, B.Sc., Technical Assistant, Associated Electrical Industries Ltd., Aldermaston, Berks.
*Salter, William John Malcolm, B.Sc., Research Student, Battersea College of Technology.
*Stead, Malcolm, B.Sc., Physicist, Nuclear Power Plant Co. Ltd., Knutsford, Cheshire.
Stocker, Brian John, B.Sc., A.R.C.S., Physicist, Mullard Research Laboratories, Salfords, Surrey.
Sullivan, Richard Arthur Lawrence, B.A., Research Student, Manchester College of Science & Technology.
Teer, Dennis Gerald, B.Sc., Scientific Officer, U.K. Atomic Energy Authority, Culcheth, Lancs.
Thurston, John Charles, B.Sc., Lecturer, South-West Essex Technical College, Walthamstow, London.

Varney, Roger, B.Sc., Technical Assistant, Rolls-Royce, Ltd., Derby.

Waller, Peter, B.Sc., Assistant Experimental Officer, Royal Aircraft Establishment, Bedford.

Winter, Kenneth Charles, B.Sc., Physicist, U.K. Atomic Energy Authority, Capenhurst, Chester.

*Woodhead, Terence, B.Sc., Research Student, University of Liverpool.

Seventy-four Students and four Subscribers were elected.

The Institute's Journals

PRINCIPAL CONTENTS OF THE JANUARY, 1959, ISSUES

Journal of Scientific Instruments : Volume 36, No. 1

High-temperature rotor bore dilatometer unit. By J. West.

The instrument measures optically the dilation due to centrifugal stresses of the bore of a steam turbine rotor under running conditions. The measurements are independent of vibration of the rotor. Light from an illuminated pinhole within an autocollimator is collimated on to a system of three mirrors supported kinematically inside a cylindrical cartridge, which is pushed into the rotor bore of the turbine. Two of the mirrors are fixed to the cartridge, and the third is hinged and connected to a feeler which is spring loaded against the rotor bore. With all three mirrors mutually at right angles, the light is reflected back to the autocollimator in exactly its own path, independent of any relative movement between the dilatometer and the autocollimator. On expansion of the rotor bore, the third mirror is displaced, tilting the returned beam of light. Since the turbine rotor is rotating, the image seen in the autocollimator appears as a circle, the diameter of which gives a measure of the dilation. The preparation of the mirror surfaces enabling them to withstand the conditions inside the turbine is discussed.

Impaction sampler for size grading air-borne bacteria-carrying particles. By O. M. Lidwell.

A sampler for air-borne bacteria is described which separates the sample into four fractions each collected on to the agar surface of a Petri dish. The sampling rate is approximately 20 ft^3/min, the size limits to the fractions are, above 18μ diameter, between 10 and 18μ, between 10 and 4μ and below 4μ. There is considerable overlap between the fractions but reasonable estimates of the median particle diameter and the dispersion of particle size within the sample can be made so long as these fall within the working limits of the instrument.

Electrolytic potentiometer as a general purpose physiological transducer. By W. G. Whittlestone.

The use of the electrolytic potentiometer as a transducer for physiological measurements is described. Two suitable types of amplifier circuit are given ; one in which the output from the electrolytic cell drives a cathode follower as a stable power amplifier, and another in which a second electrolytic cell is coupled to a recording milliammeter, and the latter used as a phase sensitive servo-motor to balance changes in the measuring cell. A transistor amplifier circuit suitable for portable equipment is given as part of the second application.

Improved Lyman-continuum flash-source of large aperture. By W. R. S. Garton.

Some of the difficulties attending use of earlier "Lyman flash-tubes," as background sources for vacuum-ultra-violet absorption spectroscopy, have been mitigated or removed in a design employing a 1 cm bore constricting tube. The successful features of the device described have resulted from use of capacitors of high resonant frequency, the design of a discharge-tube of low inductance, and avoidance of a series spark-gap.

X-ray analysis technique for very high temperatures. By E. Aruja, A.Inst.P., J. H. Welch and W. Gutt.

A new powder-diffraction technique for very high temperatures is described, in which a thermocouple combines the functions of sample support, heating, and temperature measurement. This device is simple, compact and inexpensive, and has proved to be very reliable. The maximum working temperature depends on the thermocouple material, and is normally 1750°C using 5/20 rhodium-platinum, or 1850°C with 20/40 rhodium-platinum couples.

Calorimeter with automatic control. By G. Bullock.

The temperature differences between the specimen and its surrounding reference shield in a Smith's calorimeter, modified to operate in a vacuum, is held constant by automatically adjusting the power input to the furnace. Fine adjustment is achieved by a variable reactance in the power supply. The reactance control current is obtained from a single valve d.c. amplifier, the control signal of which is the output voltage of a Wheatstone bridge network containing two photocells. Departures from the desired temperature difference cause a light spot reflected by a galvanometer to move from one to the other photocell, and so adjust the furnace power input and restore the original conditions. Specific heat-temperature curves smooth to within ±0·5% and reproducible within 3% have been obtained between 50-250°C.

Simple apparatus for measuring dielectric constants and losses from 10 c/s to 50 kc/s. By J. C. S. Richards.

A simple bridge circuit is used with a battery-operated detector. No coupling transformers or Wagner earth adjustments are required. The dielectric constant is measured by a substitution method, and the losses in terms of the equivalent parallel resistance.

Radiosonde measurement of vertical electrical field and polar conductivity. By O. C. Jones, R. S. Maddever and J. H. Sanders, A.Inst.P.

A field mill and Gerdian type of conductivity apparatus are described which can replace two standard units on a slightly modified Kew Mk. II radiosonde. They are particularly suitable for an investigation of the electrical properties of the lower atmosphere, including clouds, in non-stormy conditions. Part of each device consists of a current-controlled inductor which varies the frequency of the sonde signal. The limitations and temperature effects are briefly discussed, and the results of a typical sounding given.

Measurement of the temperature of a running thread-line. By M. F. Culpin and D. Madoc Jones.

Instruments are described which may be used to measure the temperature of a running textile thread-line. They entail the elimination of the difference in temperature between the thread-line and an independently heated thermocouple.

Simple, high-sweep-speed, single stroke oscilloscope. By W. B. Baker.

A considerable simplification of a high-sweep-speed single stroke oscilloscope is shown to result from the application of the accelerating voltage to the tube in the form of a long-tailed pulse. Apart from the power pack the oscilloscope does not incorporate any thermionic valves.

Isotopic analysis of lithium by mass spectrometry. By P. G. Bentley, J. Bishop, D. F. Davidson and P. B. F. Evans, A.Inst.P.

A mass spectrometer has been built specially for the isotopic analysis of lithium. Conventional solid-source techniques are used, but the tube unit and electronic system have several novel features. Provision is made for pumping down two ion sources at once by having three arms in the mass spectrometer tube instead of the usual two ; one arm takes the collector and the other two take ion sources, so that either source arm and the collector form a 60°-sector mass spectrometer. Each source arm is fitted with a vacuum lock to reduce pumping times.

Measurements of the isotope ratio are made semi-automatically once ion beams are obtained. By scanning the magnetic field, each ion beam is brought alternately on to the collector, where it is amplified and " remembered " as a voltage on a capacitor. The amplifier sensitivity is adjusted for one beam until the two voltages are equal, and the isotope ratio is read directly as the ratio of the amplifier sensitivities for the two ion beams. Fractionation effects in the ion source are described.

The precision of measurement of the isotope ratio is 0·7% at the 95% confidence level, and the absolute accuracy of these measurements is thought to be better than 2%. The instrument is reliable and simple to use, and analyses can be made at the continuous rate of one every twenty minutes.

Measurement of the falling velocity of particles in opaque fluids. By V. Fidleris and R. L. Whitmore, A.Inst.P.

An apparatus is described for the measurement of the falling velocity of small metallic or metal-coated particles through opaque fluids. An electromagnetic method of detecting the particles is employed.

Special type of grating, possessing the properties of a neutral filter for use in homochromatic photometry. By G. M. Sreekantath and C. A. Verghese.

A transmission grating having wedge-shaped opaque and transparent elements is described. It is shown that it has the properties of a truly neutral filter and can be used in homochromatic photometry in the place of a rotating sector disk which is difficult to operate. This new optical device may be particularly helpful when it is desired to change the intensity of a beam of light by very small amounts. It may also find useful application in absorption spectroscopy.

Surface ionization source for mass spectrometry. By R. D. Craig.

The source described is based on the principle of replacement of the usual " source slit " by a demagnified image of the ionizing filament. Using a 0·030 in. wide filament and 0·040 in. wide slits an effective source width of 0·003 in. has been obtained.

A low background flow-counter. By G. H. Bergold and G. R. Haney.

A low background flow-counter of comparatively simple construction, operating in the Geiger region, is described. The sample counter is shielded by mercury and surrounded by an anti-coincidence ring of eighteen overlapping counters, a top counter, and lead and mercury shields. The counting efficiency with 1 in. diameter steel planchets is 62% for low energy β particles such as ^{14}C ; the background is $1{\cdot}040 \pm 0{\cdot}005$ counts/min ; and the limit of sensitivity is 0·025 counts/min.

A transmission specimen holder for electron diffraction. By R. I. Garrod, F.Inst.P., and R. K. Hart.

A specimen stage for electron diffraction and electron shadow microscopy has been constructed, to enable a holder containing two transmission specimens to be inserted into, or withdrawn from, the specimen chamber without breaking the vacuum in the system. The time required to change specimens is less than one minute. Controls are provided to give specimens two independent translations in a plane normal to the electron beam and a rotation about the axis of the holder.

British Journal of Applied Physics : Volume 10, No. 1

SPECIAL ARTICLE

Solid and liquid state research with cold neutrons. By P. A. Egelstaff.

The basic physical information which can be obtained from studies of the scattering of cold neutrons by matter is reviewed in this paper. The theoretical background is covered in a general way only, but the properties of the energy transfer processes and the information they yield concerning the thermal behaviour of matter are emphasized. Experimental work is discussed historically where appropriate and numerous recent experiments are mentioned (without considering any one in detail) to illustrate the many branches of these fields into which cold neutron research is moving. With the current improvements in experimental neutron fluxes and techniques, cold neutron methods will be used extensively during the next decade for solid and liquid state research.

ORIGINAL CONTRIBUTIONS

Evaporation of thorium from carburized thoriated tungsten cathodes. By R. O. Jenkins, F.Inst.P., and W. G. Trodden.

The evaporation of thorium from carburized thoriated tungsten cathodes is shown experimentally to be approximately the same as that from similar uncarburized cathodes at the same temperature. The thorium in a carburized cathode is, however, produced continuously at an adequate rate at the operating temperature of 2000°K by reduction of the thoria by the tungsten carbide. The uncarburized cathode operates on a reserve of thorium built up by flashing at 2800°K at which temperature the tungsten reduces some of the thoria. These reactions have been examined by thermochemistry and it is shown that thorium diffuses to the surface of both types of cathode by a mechanism relatively insensitive to temperature.

On the creep recovery, relaxation and elastic " memory " of some renneted milk gels. By G. W. Scott Blair, F.Inst.P., and J. Burnett.

Small pressures are applied to one end of a column of renneted milk gel (" curd ") in a U-tube and the displacements at the other end are magnified a hundredfold. As a first approximation, the curd behaves as a Burgers Body, except that the creep curve shows a much greater " rapid " strain than does the recovery curve. Relaxation at constant strain follows a power relation between stress and time with an exponent of 0·40. The time taken for the stress to halve itself is proportional to the initial (rapid) rate of straining. Under selected

conditions, creep and relaxation curves during ageing approximate to Boltzmann's Superposition Principle. Hysteresis curves, obtained by repeated loading and unloading, show marked stiffening, followed by a (Bauschinger) softening when the direction of loading is reversed. Following suitable stressing in alternate directions, curd shows " elastic memory," i.e. the recovery curves change direction. Such behaviour necessitates additions to the Burges model. A modification of Boltzmann's Superposition equation is discussed and Graham's equation, which includes an Andrade term, has been applied to some of the data. The relative significance of the analytical and intergrative approaches to these problems is considered.

Electromagnetic fields in ferrite ellipsoids. By R. A. WALDRON, A.Inst.P.

It is pointed out that the derivation of the field in a ferrite, when immersed in a uniform field, from a knowledge of the demagnetizing factors is logically unjustifiable, since these quantities depend on a knowledge of the internal fields. The internal fields should logically be calculated from the magnetic potential equation by the application of suitable boundary conditions. Results of such calculations are given for spheres, rods of circular or elliptical cross-section, longitudinally or transversely polarized, and disks polarized perpendicularly or parallel to their planes. Some of these results have been previously reported, but are included here for the sake of completeness ; the majority, however, are believed to be original. The demagnetizing factors are also deduced from the fields.

Thermal conductivities of fused and crystalline quartz. By E. H. Ratcliffe.

The thermal conductivities of fused quartz and of crystalline quartz (heat-flow at 90° to the optic axis) have been measured by steady-state plate methods : the former over the range -150 to 50°C, and the latter at 28°C. The most probable thermal conductivity values of these two materials have been formulated as functions of temperature, having in mind their use as calibration specimens for apparatus measuring the thermal conductivities of rocks, important in the calculation of terrestrial heat-flow. Detailed description is given of apparatus and measurement methods, and the results of other observers are listed and briefly discussed.

Collection of gas-borne dust particles by means of an aspirated sampling nozzle. By S. Badzioch, Grad.Inst.P.

The efficiency of collection of gas-borne particles by an aspirated sampling nozzle is investigated theoretically and experimentally. The efficiency is shown theoretically to depend on (*a*) the ratio of the velocity of aspiration into the sampling nozzle to the velocity of the undisturbed gas stream, and (*b*) the ratio of a length representing the distance of disturbance upstream of the nozzle to the " range " of a particle. The " range " is defined as the distance a particle would travel, before coming to rest, if projected into still gas with a velocity equal to that of the gas stream. In the range of conditions investigated experimentally, which included nozzles of 0·65 to 1·90cm diameter aspirating from *turbulent* gas streams, it is found that the length representing the upstream disturbance is a function of the diameter of the nozzle.

Theorem concerning anisotropic dielectrics. By G. Power, A.Inst.P.

A theorem is enunciated which enables the perturbation effects of an anisotropic dielectric cylinder set in a general two-dimensional electric field to be written down. The results are extended to allow for certain other finite conducting or insulated boundaries, thus providing simple solutions for some apparently difficult problems.

Preparation of metal film resistors on laminated plastics. By G. Siddall and G. Smith.

Some properties of metal resistance films on resin-bonded glass cloth have been investigated. Plastics laminates bonded with different polymers were coated with films of nickel-chromium alloy by vacuum evaporation and with sandwich films of gold between bismuth oxide layers deposited by sputtering. Glow discharge cleaning was essential before evaporation to make adherent films. Silicone resin bonded laminates were unsuitable for preparing stable resistors, because they had a large number of surface defects produced by strains arising during the curing process. Melamine bonded laminates were decomposed by ion bombardment during discharge cleaning or sputtering. The resistors were tested under a load of 1 W/in. of film area over a period of three months. Resistors which became non-conducting during the test were found to break down invariably along surface scratches in the base material. The most stable resistors on plastics bases were produced with epoxy or polyester resin bonded laminates, and with the metal films protected by a melamine lacquer. Nickel-chromium films up to 800 Ω/square and gold films up to 50 Ω/square reached a stable resistance value after an ageing period of about eight weeks.

Cooling of a spinning thread-line. By E. H. Andrews, A.Inst.P.

The cooling of an extruded stream of molten polymer is considered for the case in which the solidified thread-line is " wound-up " some distance from the spinneret. The heat flow equations are set up and solved approximately with the aid of empirical data. The predicted temperature-distance relations appear to be substantially correct, though the predicted radial temperature distribution in the thread-line is only accurate to within 20%.

Interaction between two equal-sized equal-settling spheres moving through a viscous liquid. By G. F. Eveson, E. W. Hall, Grad.Inst.P., and S. G. Ward.

Details are given of an experimental investigation of the interaction between two equal spheres settling through a viscous liquid in the presence of each other at various distances between sphere centres and with the line of centres at various angles to the horizontal. The results are represented by simple empirical equations. These results are discussed in relation to the theoretical predictions of other workers.

Approximate solution of a non-linear differential equation giving the temperature distribution in the positive column of a static arc. By H. Goldenberg.

An approximate method is presented for the solution of the differential equation giving the temperature profile of the positive column of a static arc, when heat conduction only is taken into account. The method of Eyres, Hartree and others is first used to change the dependent variable in order to replace the two non-linear functions of temperature present in the differential equation, namely the electrical and thermal conductivities, by a single non-linear function. When this non-linear function is approximatel by a piecewise linear function, the basic differential equation can be integrated directly, and the temperature profile obtained. An example shows close agreement with King's results.

Torsional vibrational experiments on rectangular concrete beams. By R. Jones.

Earlier anomalous results obtained in measuring the dynamic shear modulus of specimens of concrete by a torsional resonance technique are now explained satisfactorily. A theory, given by Davies in 1938, predicts discrepancies in the apparent shear modulus obtained at higher harmonic resonances due to warping of the rectangular section during vibration. The experimental results are in extremely good agreement with Davies's theory, and it is found that the corrected shear modulus is not significantly influenced by the frequency at which it is measured. This conclusion agrees with the results obtained from torsional resonances on a concrete beam of circular cross-section for which no correction is required.

Appointments Vacant

The inclusion of particulars of a vacancy must not be taken to imply that the Institute necessarily approves of the terms offered or that might de offered. Candidates should satisfy themselves that these are satisfactory, and they may always refer to the Institute for advice.

McMASTER UNIVERSITY
HAMILTON, CANADA

THEORETICAL PHYSICS

The Department of Physics, McMaster University, has an opening for an additional theoretical physicist with a research interest in solid state physics. Salary and rank will depend upon the qualifications of the appointee, but the minimum annual stipend will be at least $7,040.
Further information concerning this opening may be had from the Chairman of the Department of Physics or from Dr. M. A. Preston.

McMASTER UNIVERSITY

GRADUATE SCHOLARSHIPS IN PHYSICS

Applications are invited for Graduate Scholarships in the Department of Physics, McMaster University, from students qualified to register in courses leading to the M.Sc. and Ph.D. degrees. These scholarships may be supplemented by departmental assistantships, requiring ten hours per week service during the seven-month academic year, to provide a yearly income of $1,700 – $2,100.
Theoretical and experimental research is in progress in several branches of nuclear and solid state physics.
Graduate Calendars and application forms for graduate study may be obtained from the Secretary of the Faculty of Graduate Studies. Further information concerning the types of research in progress and application forms for scholarships may be obtained from Professor H. E. Duckworth, Department of Physics, Hamilton College, McMaster University, Hamilton, Ontario, Canada.

MICROWAVE MATERIALS

PHYSICISTS and RESEARCH ENGINEERS are required to join a group studying the basic and applied scientific aspects of both absorbent and transparent materials in the microwave region of the spectrum. There are also opportunities for suitable candidates to assist in progressing new developments into pilot production. The location is an applied research establishment situated in a country district in South Northants. Please reply to : The Personnel Department, The Plessey Company Ltd., Caswell, Towcester, Northants, quoting reference " Microwave/4."

A qualified ELECTRICAL ENGINEER or PHYSICIST is required to take charge of product development at the United Insulator Division of the Telegraph Condenser Company Ltd., Oakcroft Road, Chessington, Surrey. The work involves design and pre-production work on such products as small insulators, fuse links and ceramic piezoelectric transducers.
Applications should be made to the Technical Manager.

McMASTER UNIVERSITY

POST - DOCTORAL FELLOWSHIPS IN PHYSICS

Applications are invited for National Research Council and other Post-Doctoral Fellowships tenable in the Department of Physics, McMaster University. Successful applicants may choose to work full-time on their research or to supplement their research with a modest amount of lecturing.
Inquiries and applications should be addressed to Professor H. E. Duckworth, Chairman, Department of Physics, McMaster University, Hamilton, Ontario, Canada.

OPERATIONAL RESEARCH, AIR MINISTRY

Senior Scientific and Scientific Officer class in Scientific Adviser's department. Qualifications : First or Second Class Honours Degree in mathematics, statistics, or a physical science such as physics, engineering. Honours Degree in a natural or social science acceptable provided candidate possesses at least mathematical knowledge at G.C.E. Advanced level. Appointments offer great scope and interest to versatile scientists capable of working well with Service officers and of adopting methods suited to Service environment. Work is mainly Operational Research in wide variety of subjects of concern to Royal Air Force including tactics, technical development and logistics and offers S.S.O., and S.O. entrants valuable experience in principles of Operational Research. Salaries London S.S.O. £1,190 to £1,410. S.O. £635 to £1,110. Outside London slightly lower. Salaries for women being raised by stages to men's rates. Forms from M.L.N.S. Technical and Scientific Register (K), 26 King Street, London, S.W.1 (quoting A.158/8A/NB). Closing date January 24, 1959.

MINISTRY OF SUPPLY

Armament Research and Development Establishment, Fort Halstead, Sevenoaks, Kent, requires Physicists, Electronic, Electrical and Mechanical Engineers for work on guided weapons and fire control systems ; Physical Chemists for explosives phenomenology ; Metallurgists for problems in physical metallurgy. Appointments in grade (*a*) Senior Scientific Officer (minimum age 26, at least three years postgraduate research experience) or (*b*) Scientific Officer, 1st or 2nd honours degree or equivalent. Salary ranges (*a*) £1,130 – £1,330, (*b*) £595 – £1,050 (male, in provinces). Rates for women same by 1961. Superannuation under F.S.S.U. Opportunity for those under 31 to compete for pensionable posts. Candidates should indicate fields of work in which interested. Forms from M.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1. (quote A454/8A).

MINISTRY OF SUPPLY

Royal Aircraft Establishment, Farnborough, Hants., requires physicists, engineers and mathematicians for advanced research work in wide variety of problems arising from exploration of new regimes of flight, covering ballistic missile, aircraft and guided weapons fields, and including extensive experimental programs for which well equipped modern laboratories and flight facilities are available. Appointments of (*a*) senior scientific officer (minimum age 26, and at least three years postgraduate research experience) or (*b*) scientific officer. 1st or 2nd honours degree or equivalent required for both grades. Salary ranges (*a*) £1,130 – £1,330, (*b*) £595 – £1,050 (male in provinces ; rates for women the same by 1961). Superannuation under F.S.S.U. Opportunity for those under 31 to compete for pensionable posts. Good promotion prospects. Applications also invited from students expecting to graduate in 1959. Interviews for undergraduates will normally be held at Farnborough during Easter vacation 1959, but interviews can also be arranged at other convenient dates. Forms and illustrated booklet from M.L.N.S. Technical and Scientific Register (K), 26 King Street, London, S.W.1. (quote A.469/8A).

THE PILKINGTON GROUP

GLASS MANUFACTURERS

PHYSICISTS AND ENGINEERS

A new £3,000,000 grinding and polishing plant is being erected at the

DONCASTER

factory to deal with the steadily increasing demand for thin polished plate glass for the motor industry. The staff of the

TECHNICAL DEVELOPMENT DEPARTMENT

is accordingly being increased. If you are in the 22-30 age group and have a good honours degree in

PHYSICS OR MECHANICAL ENGINEERING

you are invited to apply to

Personnel Officer
(Graduate Recruitment)
Pilkington Brothers Limited
St. Helens, Lancs.

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.
LIVERPOOL

This Company is engaged on large-scale projects which offer a real challenge to those seeking an outlet for their scientific or engineering abilities and affords excellent opportunities for experience and advancement. The work involves the design and manufacture of electronic equipment using solid state devices and the most modern electronic techniques.
The programme of work is expanding and in consequence there are staff vacancies at all levels in the following fields :

(*a*) **RESEARCH AND DEVELOPMENT WORK ON COMPONENTS AND ELECTRONIC DEVICES**

(*b*) **DESIGN OF SYSTEMS AND CIRCUITS UTILIZING DIGITAL AND ANALOGUE TECHNIQUES**

(*c*) **ENGINEERING DESIGN FOR PRODUCTION**

(*d*) **COMMISSIONING AND FIELD TRIALS**

Suitable academic qualifications range from an Ordinary National Certificate in Electrical Engineering to an Honours Degree in Electrical Engineering, Mechanical Engineering, Mathematics and Physics. A limited number of posts are available for persons with postgraduate academic training.
Practical experience in the field of light current engineering is desirable but adequate training will be given to applicants who are suitably qualified but lack this practical experience.
Salaries will be realistic and will be determined by qualifications, experience and the type of responsibility. Successful applicants will be required to join the Company's generous Contributory Pension Scheme. Assistance with housing and removal would be given in approved cases.
Any person who feels qualified to contribute to this work should apply for an application form to the

PERSONNEL MANAGER, AUTOMATIC TELEPHONE & ELECTRIC CO. LTD., STROWGER WORKS, LIVERPOOL, 7

CAREERS FOR ENGINEERS AND SCIENTISTS
IN THE GENERAL ELECTRIC COMPANY LTD.

The Engineering activities of the G.E.C. are backed by a research and development organization unequalled in the industrial field.

Engineers and physicists in the laboratories and works of the Company are engaged on a varied program of fundamental and applied research. Their projects are absorbing, vital and immediate, and encompass such studies as scatter propagation systems, travelling wave tubes for Eurovision amplifiers, electronic switching and telemetering devices and the development of new semi-conductor materials. Such projects and many more require men and women with first-class minds. If you are seeking direct employment or graduate training, write for further information to : The Controller, Education and Personnel Services.

For school leavers there are university scholarships as well as university and student sandwich schemes of training leading to professional work as engineers and scientists.

For further details write to :

G.E.C.

THE CONTROLLER EDUCATION AND PERSONNEL SERVICES (IPB)
THE GENERAL ELECTRIC COMPANY LTD.,
MAGNET HOUSE, LONDON, W.C.2.

A World-wide Organization Employing 70,000 People

SIEMENS EDISON SWAN LIMITED

(AN A.E.I. COMPANY)

Research Laboratory

Cable Research

Engineer or Physicist

required with a special interest in high voltage insulation to work on aspects of insulation failure and cable design. Practical experience and theoretical interest desirable. A competative salary will be offered and ideal working conditions in a new well equipped research laboratory. Housing available to rent or purchase. An opportunity to discuss this situation may be arranged by writing to

THE PERSONNEL OFFICER, SIEMENS EDISON SWAN RESEARCH LABORATORY, WEST ROAD, TEMPLE FIELDS, HARLOW, ESSEX

ATOMIC ENERGY RESEARCH ESTABLISHMENT
HARWELL
GRADUATE PHYSICISTS

Ref. 1270/110
Opportunities exist for Graduate Physicists (1st or good 2nd) with enthusiasm and ingenuity for research into either (*a*) the solution of scientific and technical problems by the use of all types of radioisotope techniques, or (*b*) the development of new measuring techniques for radioactive materials and ionizing radiations and the investigation of limits of performance of detectors.
Salary : up to £1,120 (Scientific Officer).

Ref 1296/110
There are opportunities for Graduate Physicists in teams studying (*a*) the effects of irradiation upon the fundamental properties of metals and ceramics, (*b*) the effects of irradiation on graphite (Wigner Energy Effects). A 1st or good 2nd in physics or metallurgy is required; experience in solid state physics an advantage.
Salary : up to £1,425 depending mainly on age and postgraduate experience.
Please send a postcard quoting appropriate reference number, U.K.A.E.A., A.E.R.E., Harwell, Berks., for details.

PHYSICIST (Senior Scientific Officer) required by L.C.G. in Scientific Branch at County Hall for research work on properties of materials and in field of health physics. Good honours degree in physics required. General physical experience and knowledge of radiochemical equipment desirable. Salary within scale £1,037 10s. – £1,305 according to qualifications and experience. Permanent and pensionable. Application forms from Medical Officer of Health (PH/D. 1/A), County Hall, London, S.E.1, by January 24, 1959. (2496).

PLESSEY NUCLEONICS LTD.
NORTHAMPTON
LABORATORY TECHNICIAN

A laboratory technician with two to five years' experience on development of radiation detectors for the nuclear energy industry, should investigate an opportunity with this Company. We have a vacancy for which a knowledge of Light Engineering and general physics laboratory practice, including high vacuum techniques, is desirable. Construction and evaluation of new types of detector, and the development of new techniques of construction are also involved. H.N.C. (min.). Good working conditions. Canteen facilities. Pension Scheme. Salary will please successful applicant. Write Personnel Dept. (L.T.) Plessey Nucleonics Ltd., Weedon Road, Northampton.

PLESSEY NUCLEONICS LTD.,
NORTHAMPTON
PHYSICISTS

Physicists with a degree in their subject, and tempered with two to five years' experience in research and development work are sought by this Company. They would be members of a laboratory team engaged in the application of the techniques of nuclear physics to a wide range of problems, and in research on a number of interesting projects involving the use of scintillation counters of various types. Salaries genuinely related to worth, ability and potential recognized. The special opportunities for advancement in this field are well-known, our particular conditions are good and in the first flight of springboards. Applications to Personnel Dept., Plessey Nucleonics Ltd., Weedon Road, Northampton.

For All Insurances

WALTER HERRIOT & CO. LTD.

Incorporated Insurance Brokers

BROAD STREET HOUSE
54 OLD BROAD STREET
LONDON, E.C.2

Telephone : LONdon Wall 7007

COURSES

BATTERSEA COLLEGE OF TECHNOLOGY : A course of six lectures on " The Control of Colour in Manufacturing Industries " on Thursdays, 7-9 p.m., commencing February 12. Fee 10s. Further details and enrolment forms obtainable from the Secretary (Chemistry courses), Battersea College of Technology, London, S.W.11.

COLLEGE OF TECHNOLOGY
BIRMINGHAM
DEPARTMENT OF PHYSICS
POSTGRADUATE COURSE

The following postgraduate courses will be held weekly, 6.30 p.m., at The College, Gosta Green, Birmingham, starting in the Spring Term of 1959.

ACOUSTICS AND NOISE MEASUREMENT : From Wednesday, January 14, for 10 weeks for students with ordinary B.Sc., or H.N.C. Fee 2½ guineas.

FLUCTUATIONS : From Monday, January 12, for 8 weeks for students with good physics degree. Fee 3 guineas.

TRANSISTORS: From Monday, January 12, for 8 weeks for students with a basic knowledge of physics and electronics. Fee 2½ guineas.

VACUUM TECHNIQUE : From Wednesday, January 14, for 10 weeks for students with general works experience. Fee 2 guineas.

REACTOR POWER TECHNOLOGY : From Wednesday, January 7, for 12 weeks for students with ordinary B.Sc. Fee 3 guineas.

Further details from Head of Physics Department. Students should register at first meeting of the class.

MIDDLESEX COUNTY COUNCIL EDUCATION COMMITTEE

BRUNEL COLLEGE OF TECHNOLOGY

WOODLANDS AVENUE, ACTON, W.3

BASIC HIGH VACUUM TECHNOLOGY

by D. J. Pacey, B.Sc., A.Inst.P., Senior Lecturer in Physics, Brunel College of Technology

A course of twelve lectures with related practical work will be given on Mondays commencing January 5, 1959, from 6.30 p.m. to 9 p.m. Fee £1.

APPLIED ULTRASONICS

by J. Blitz, M.Sc., A.Inst.P., Lecturer in Physics, Brunel College of Technology

A course of six lectures will be given on Tuesdays commencing January 20, 1959, at 7 p.m. Fee 10s.

These courses will be of interest to graduates and holders of the H.N.C. in Engineering and Science subjects.

Further details may be obtained from the Principal.

C. E. Gurr, M.Sc., Ph.D., Clerk to the Governing Body.

Chartered Patent Agents

W. H. BECK, GREENER AND COMPANY

7 Stone Buildings, Lincoln's Inn, London, W.C.2

Chancery 2535

PRINTED BY F. J. MILNER AND SONS LIMITED, COMMERCE ROAD, BRENTFORD, MIDDX.